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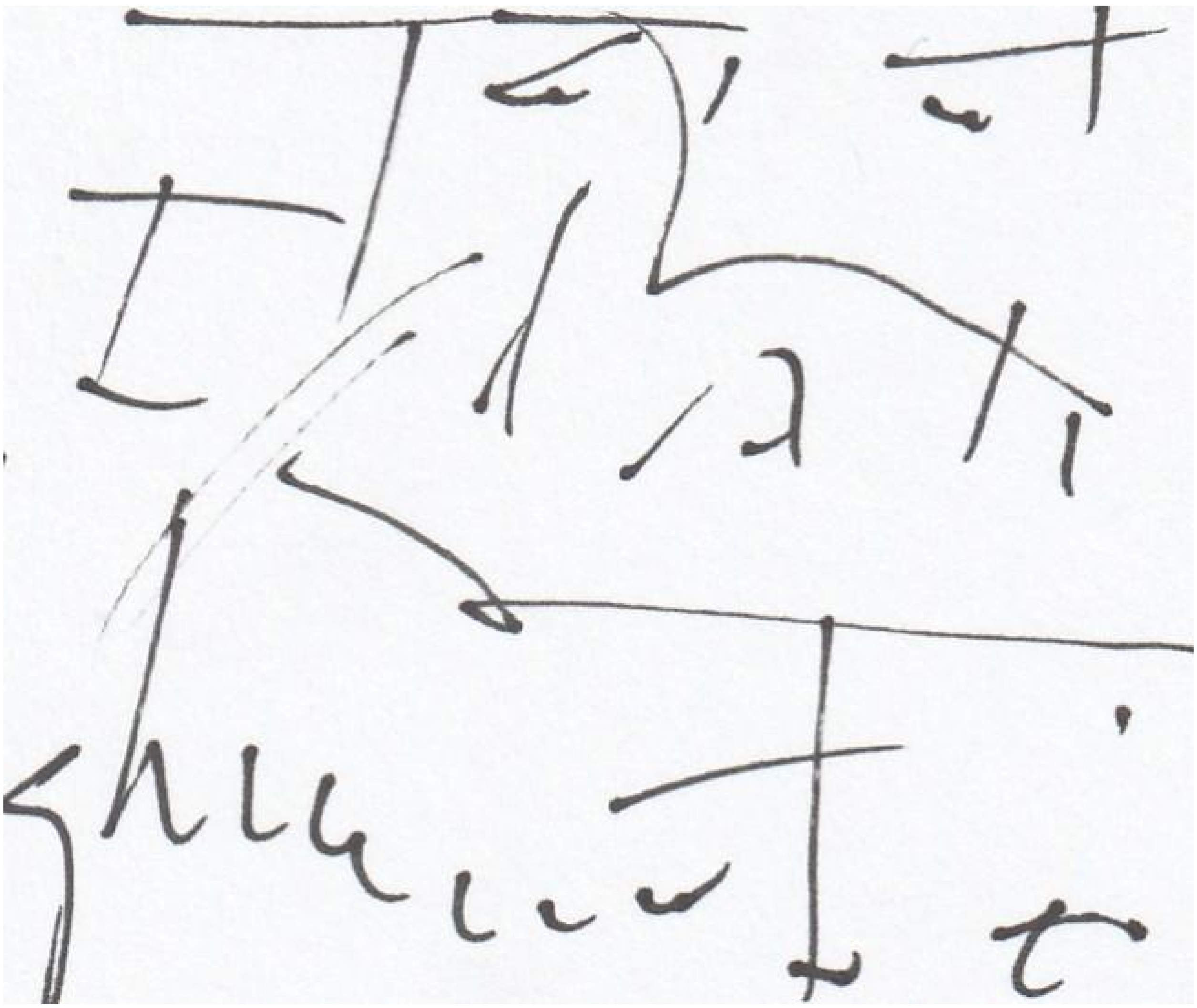
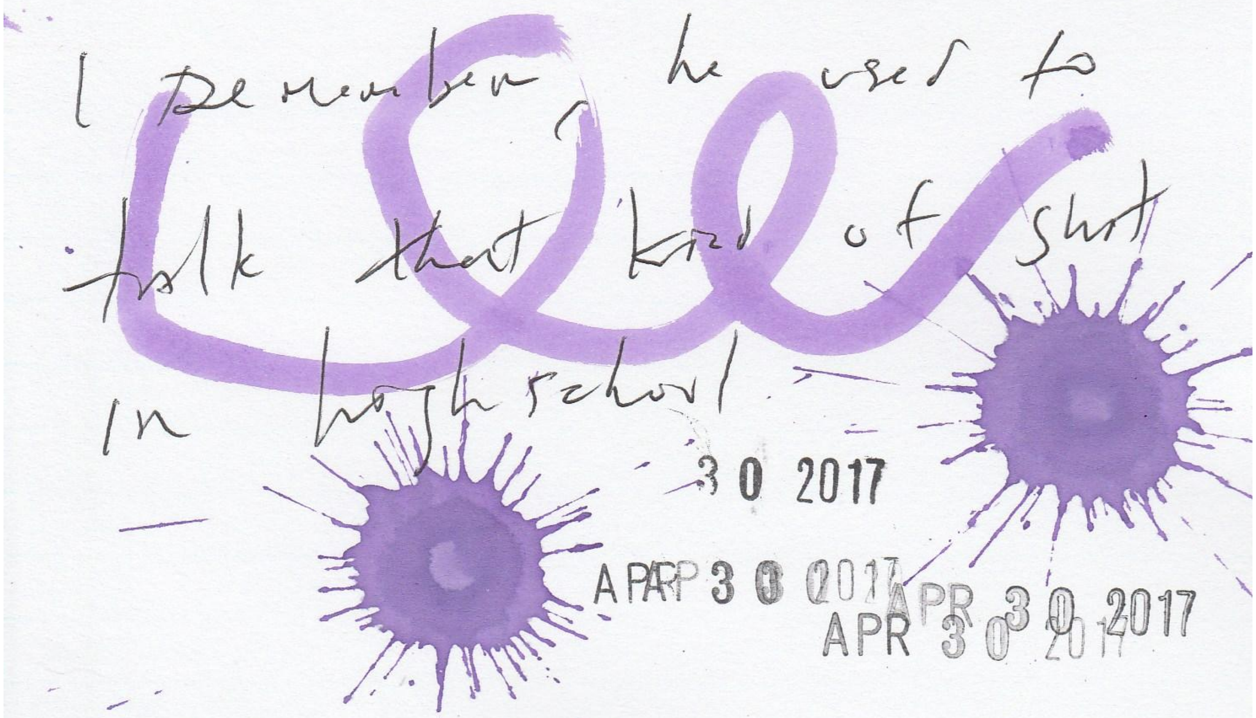
visual poems ongoing research 2017 -vol. 5

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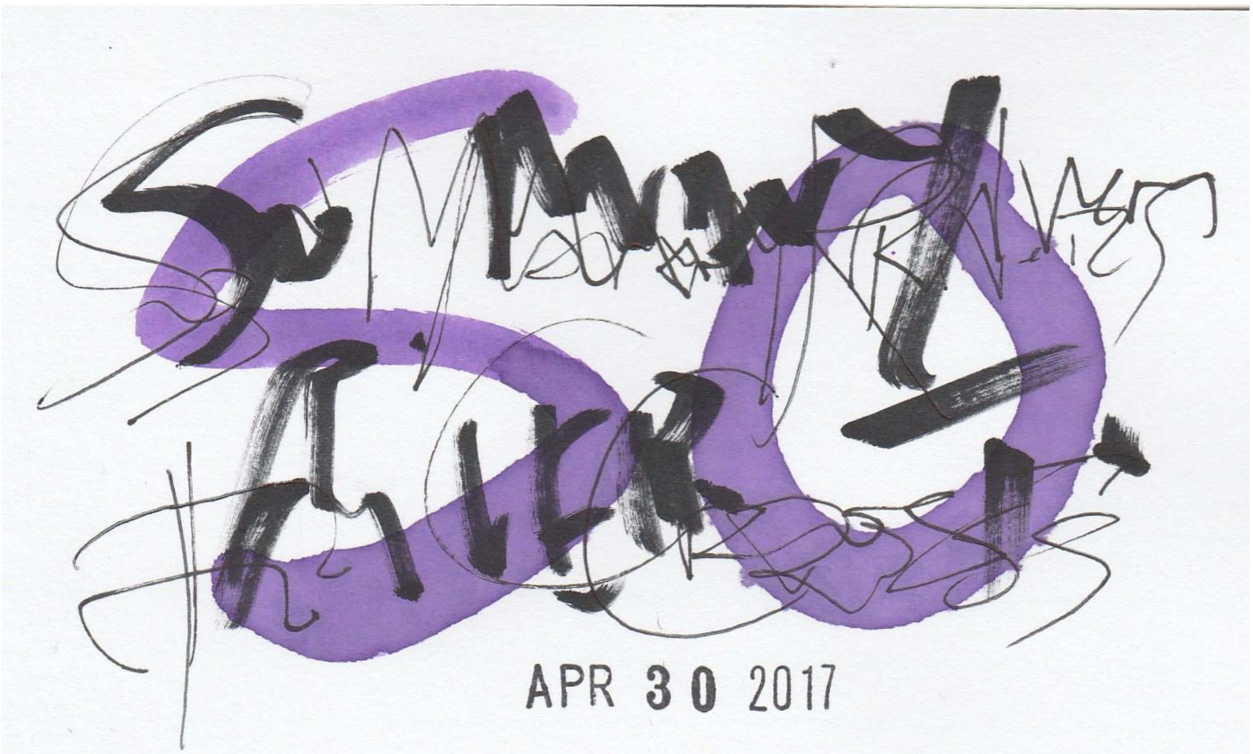
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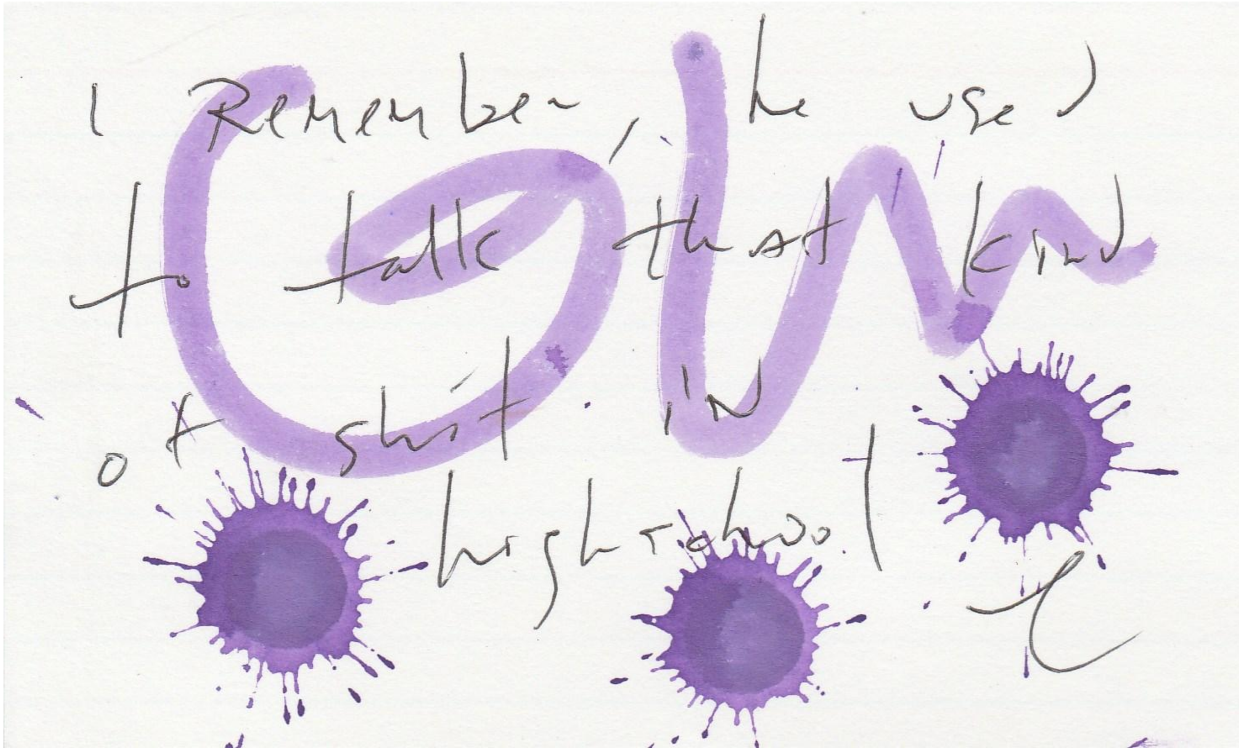
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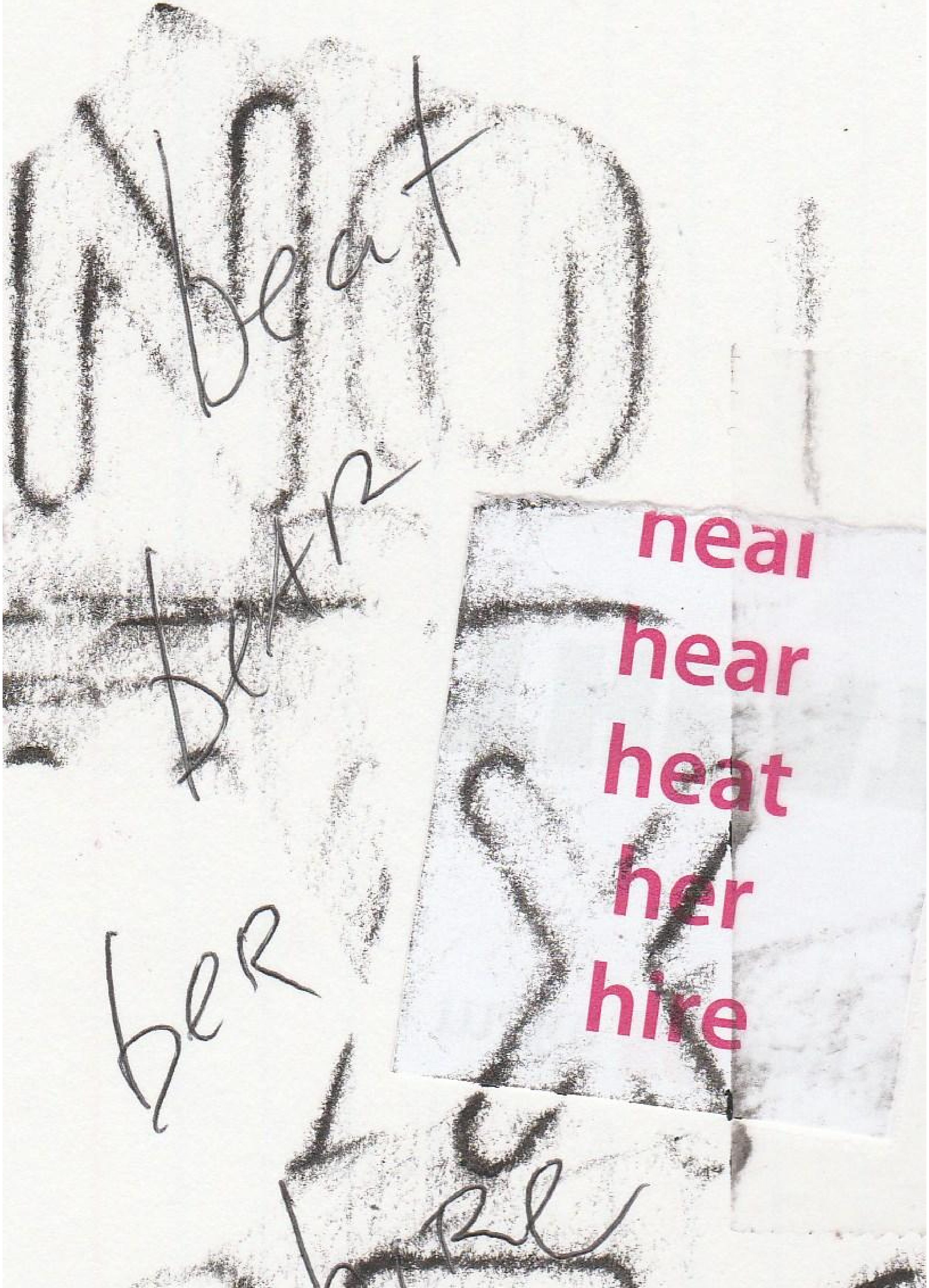
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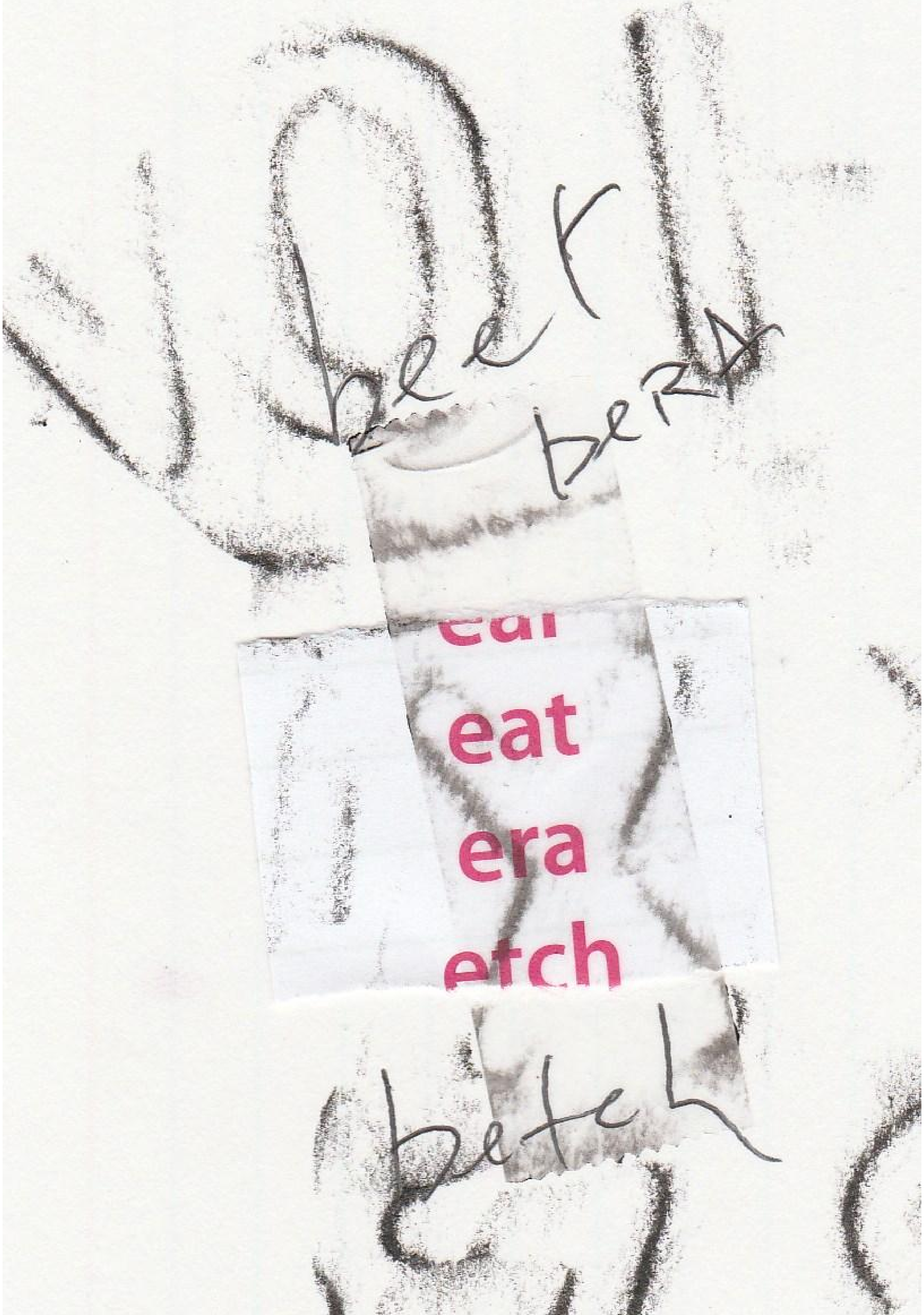
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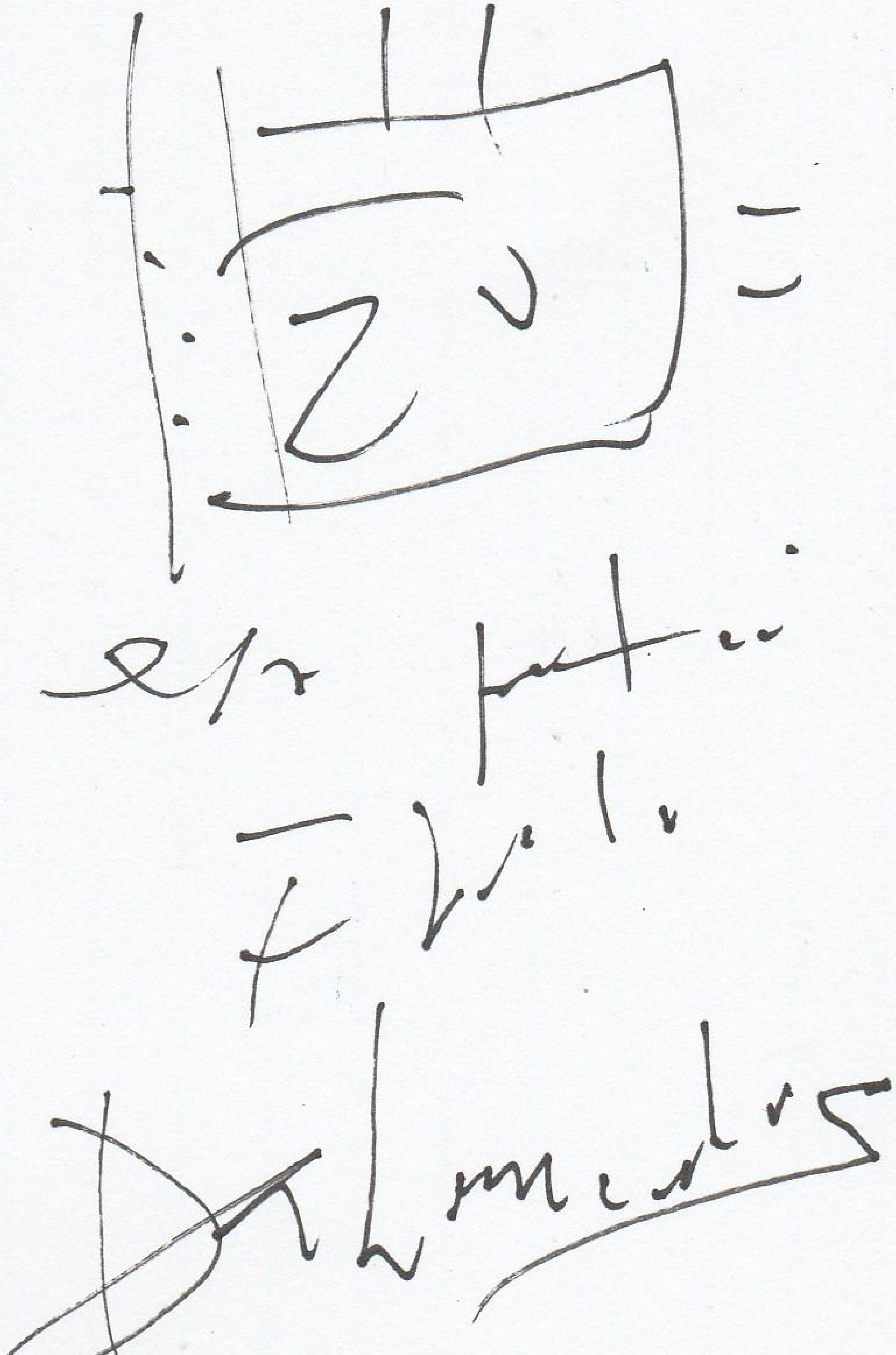


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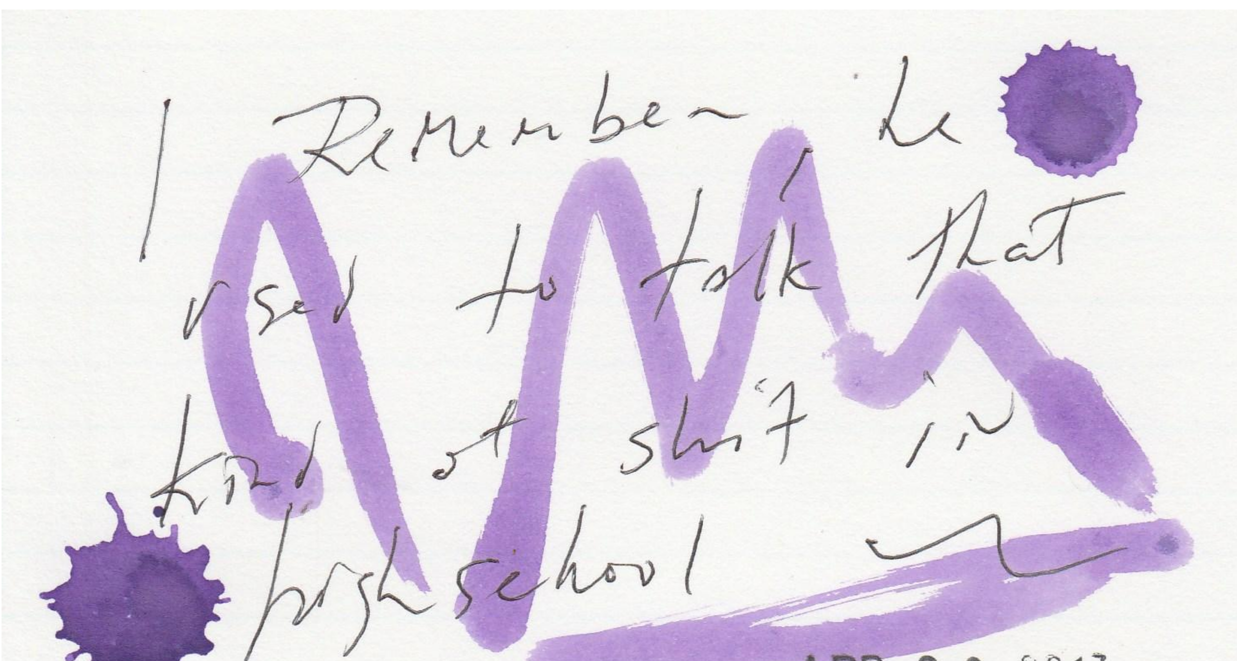
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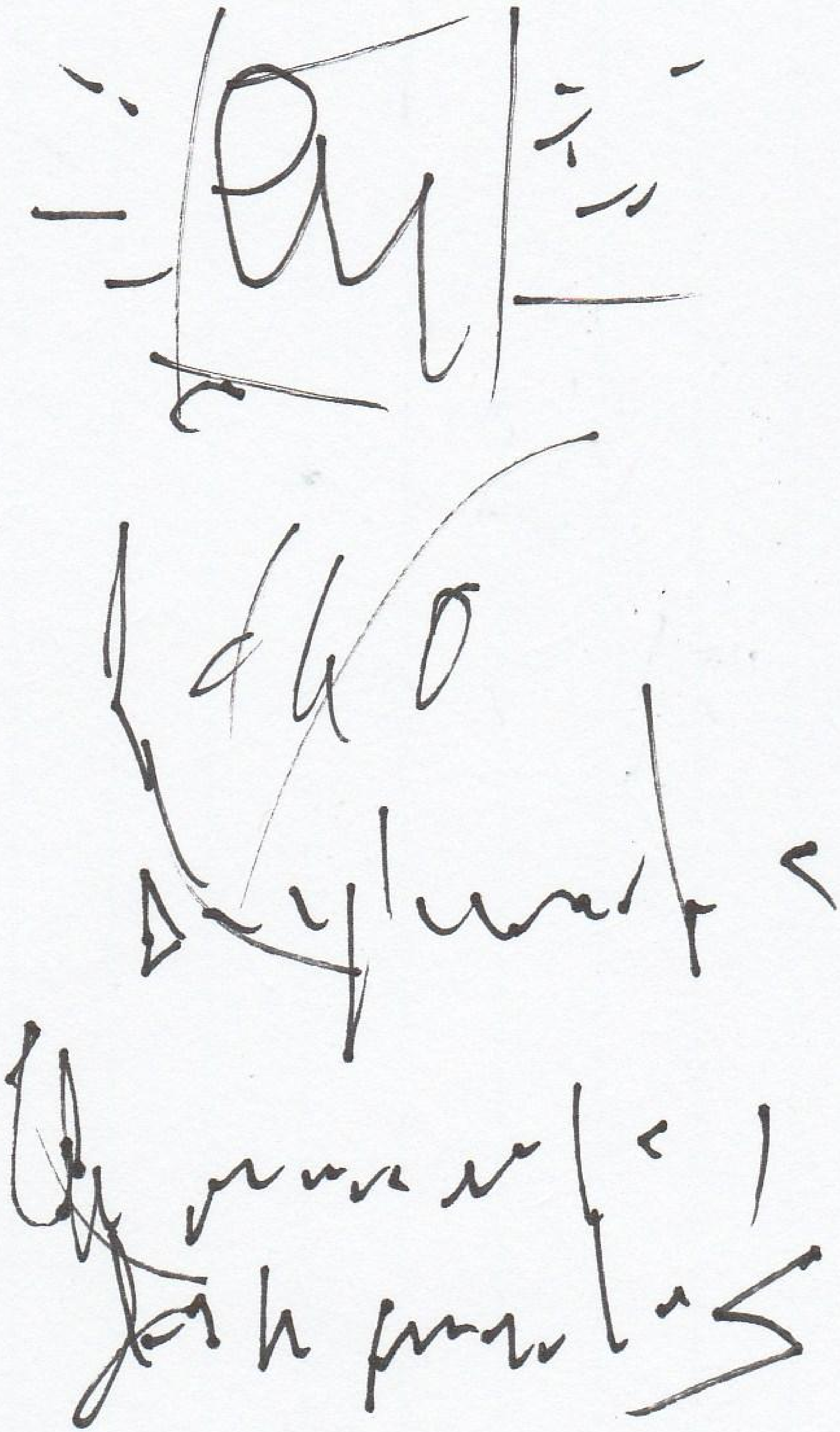

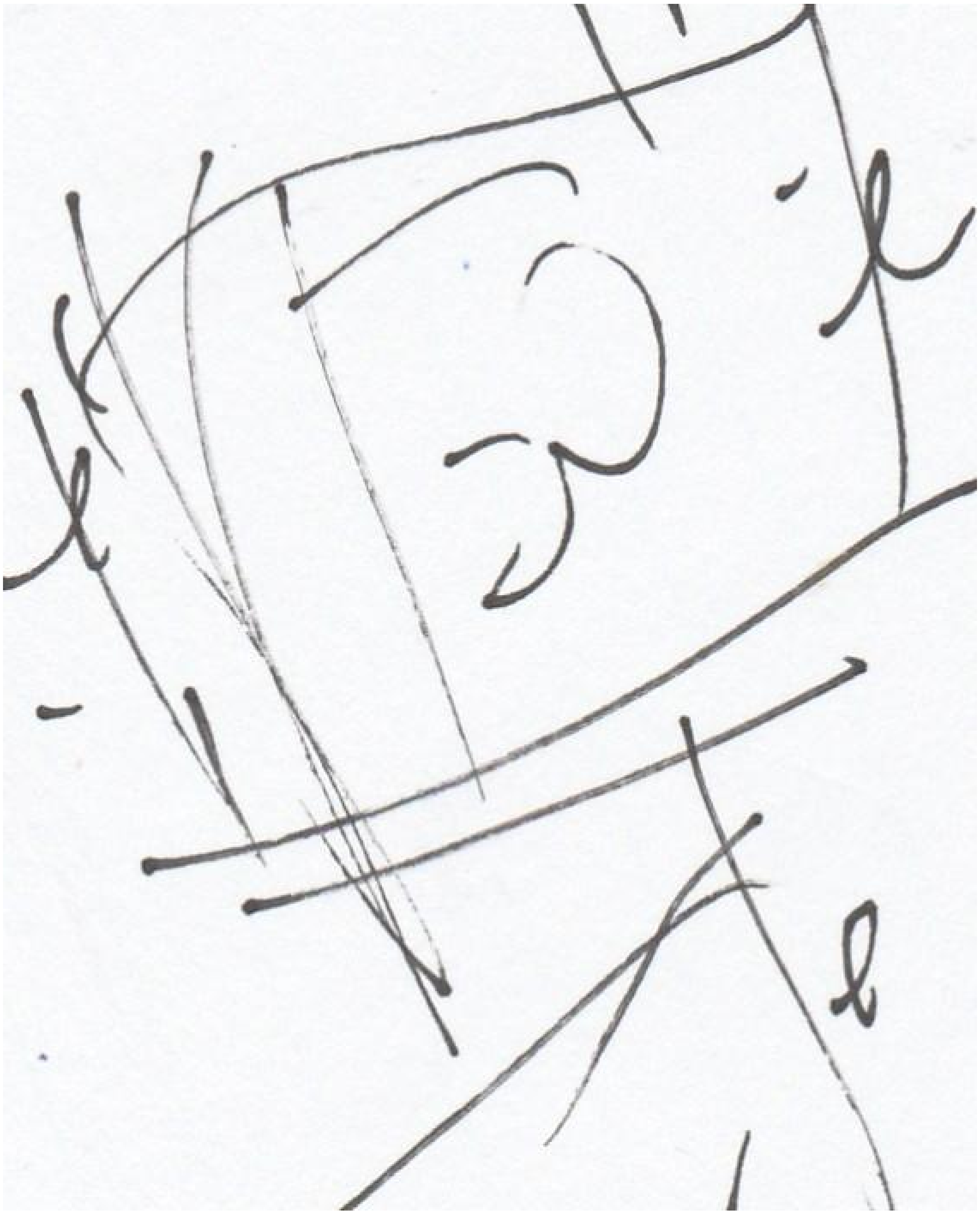

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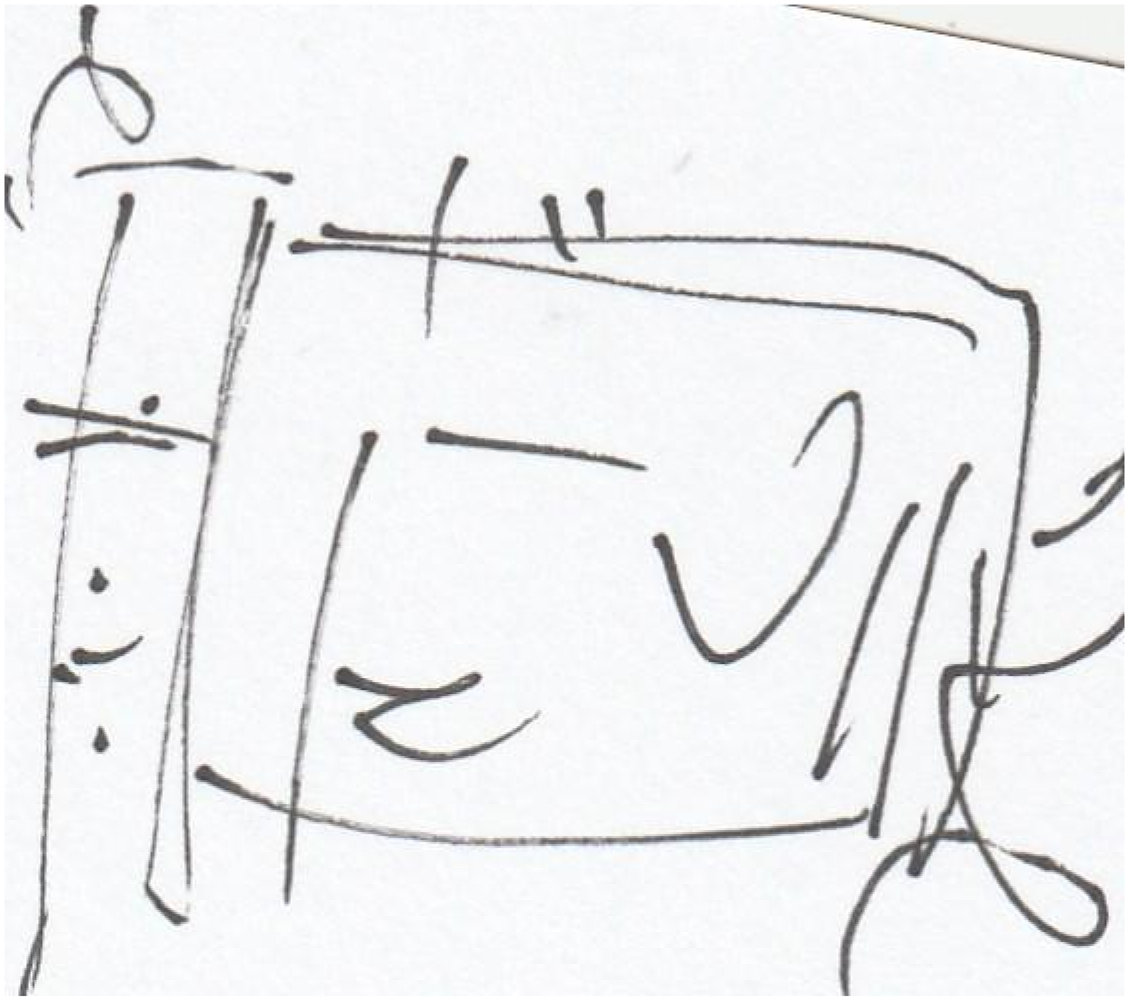

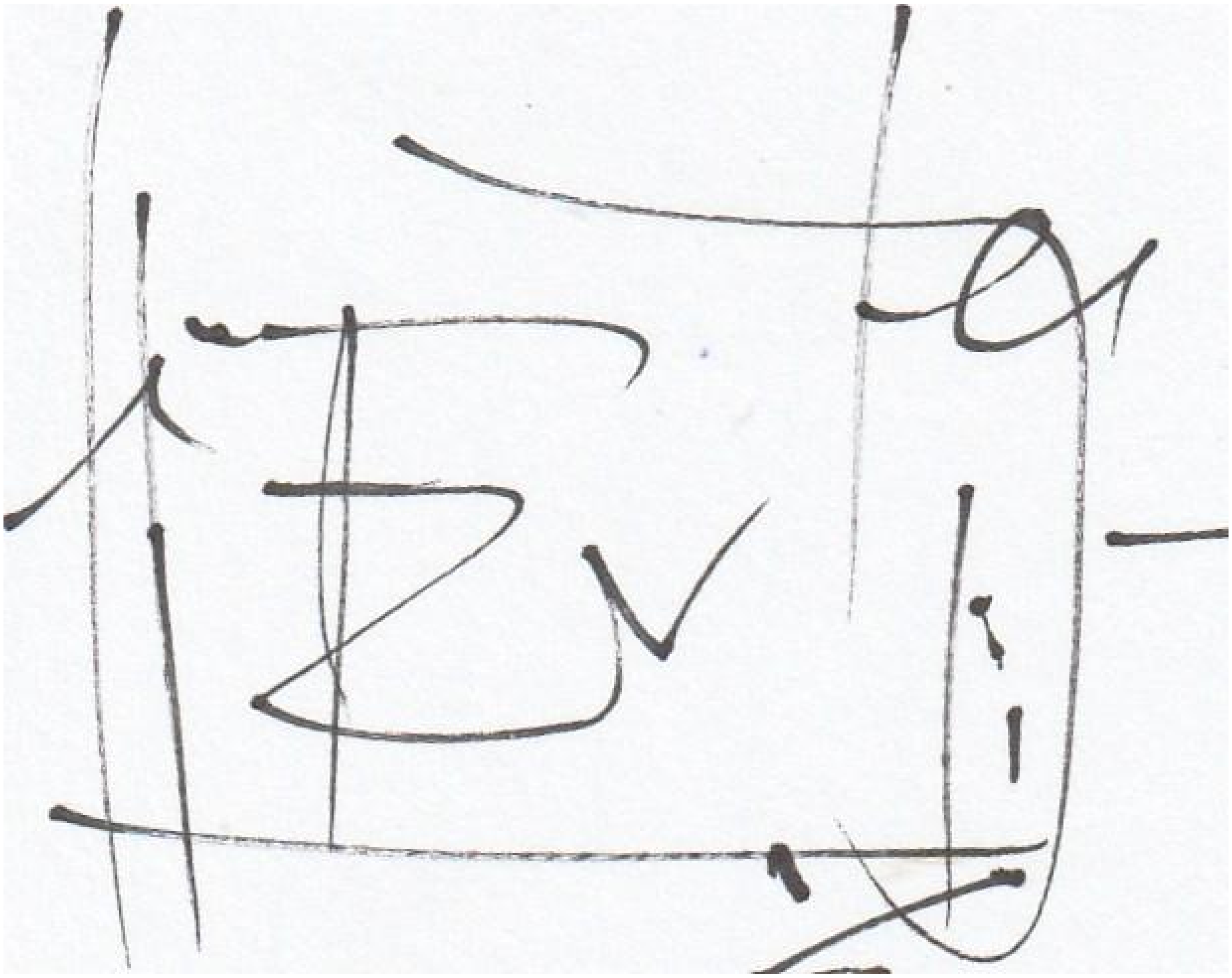

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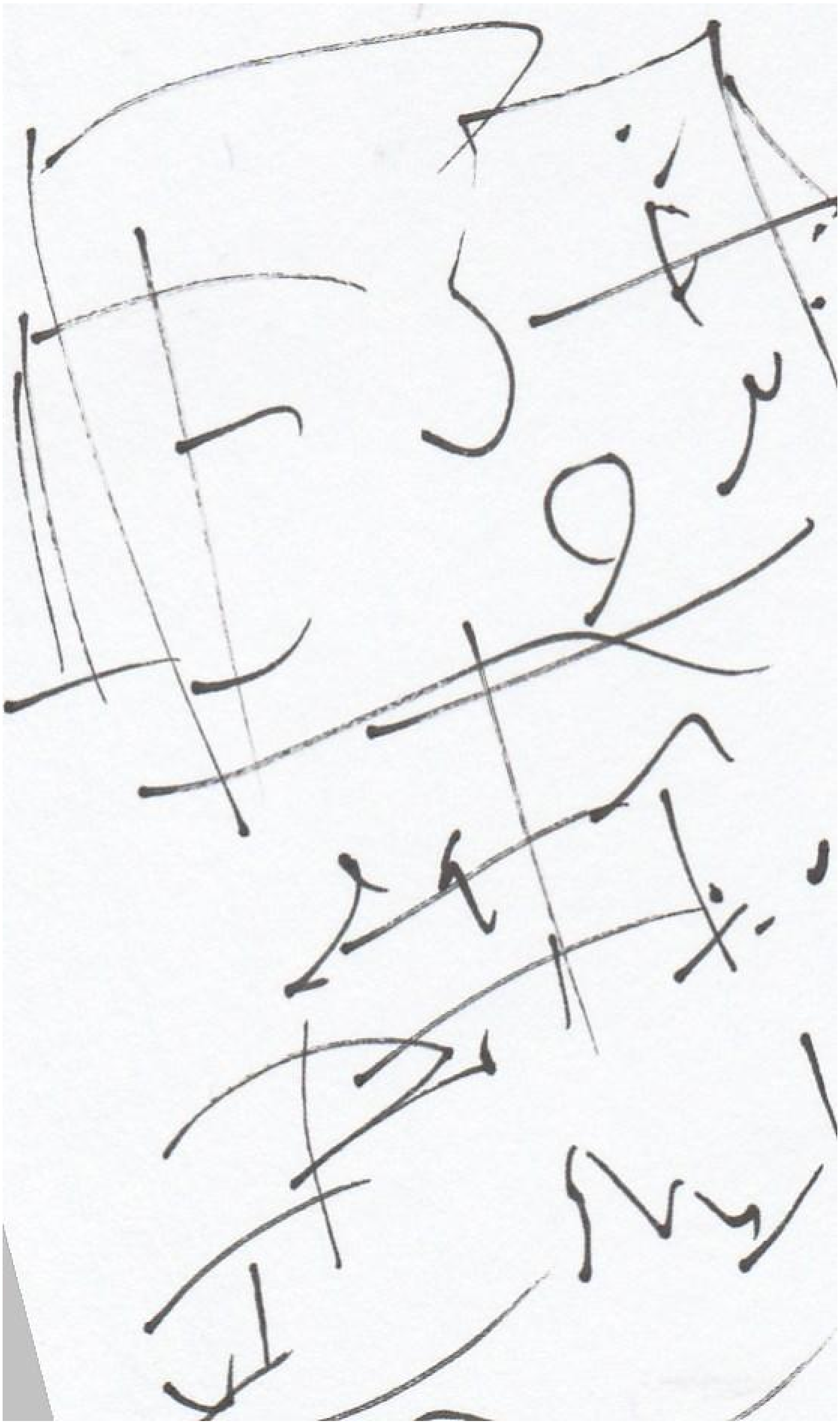

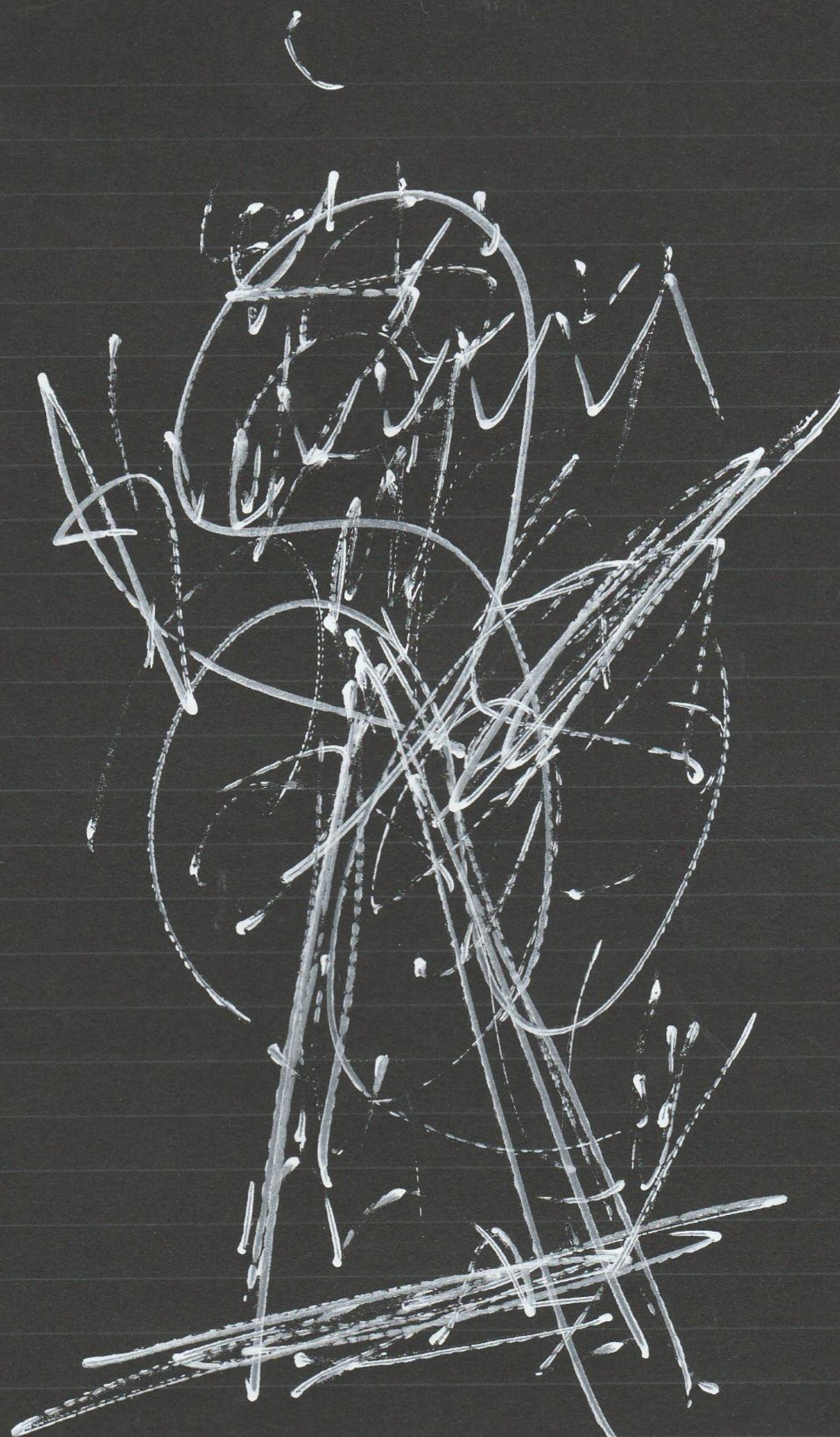


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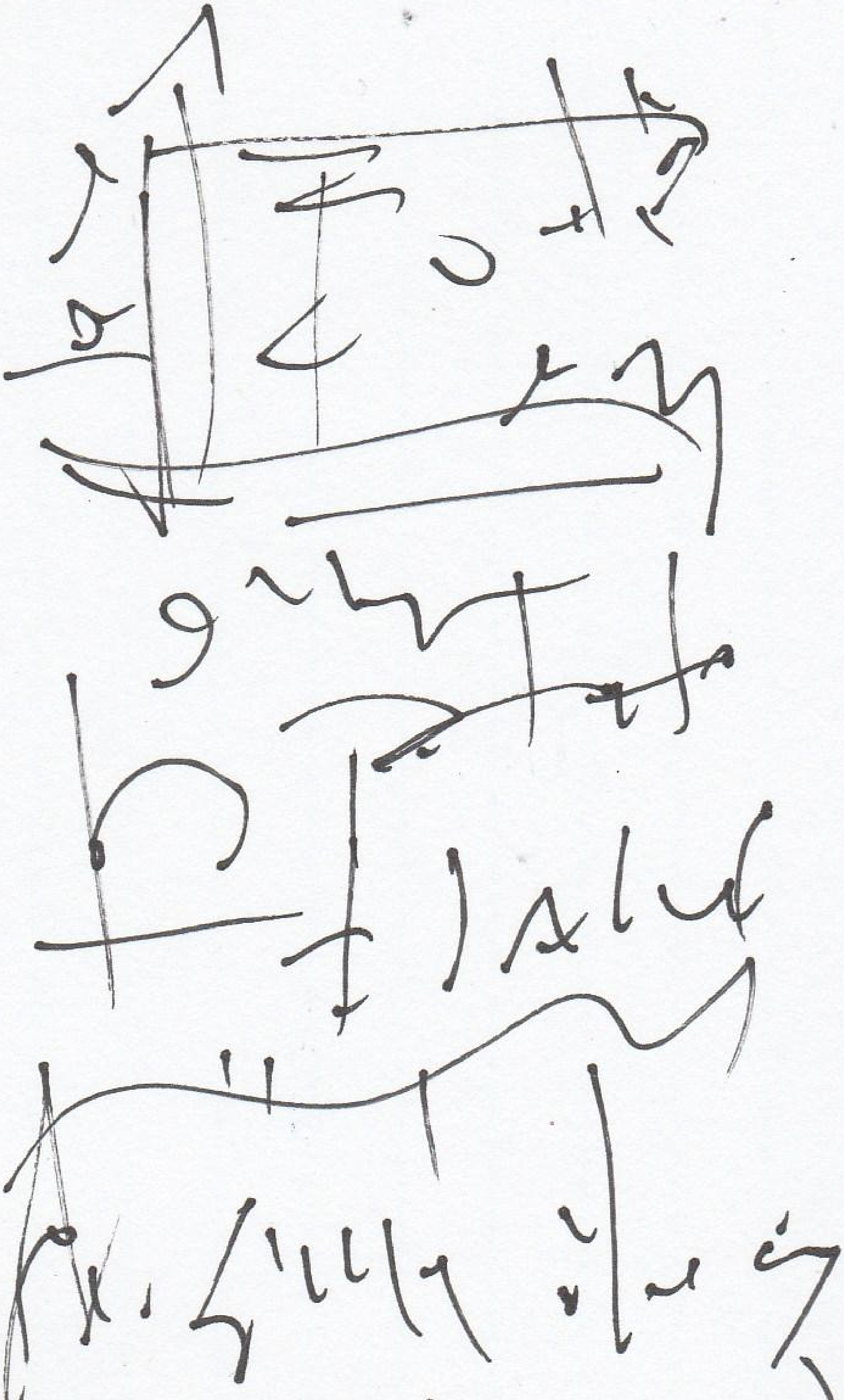

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Writing

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What does it say?

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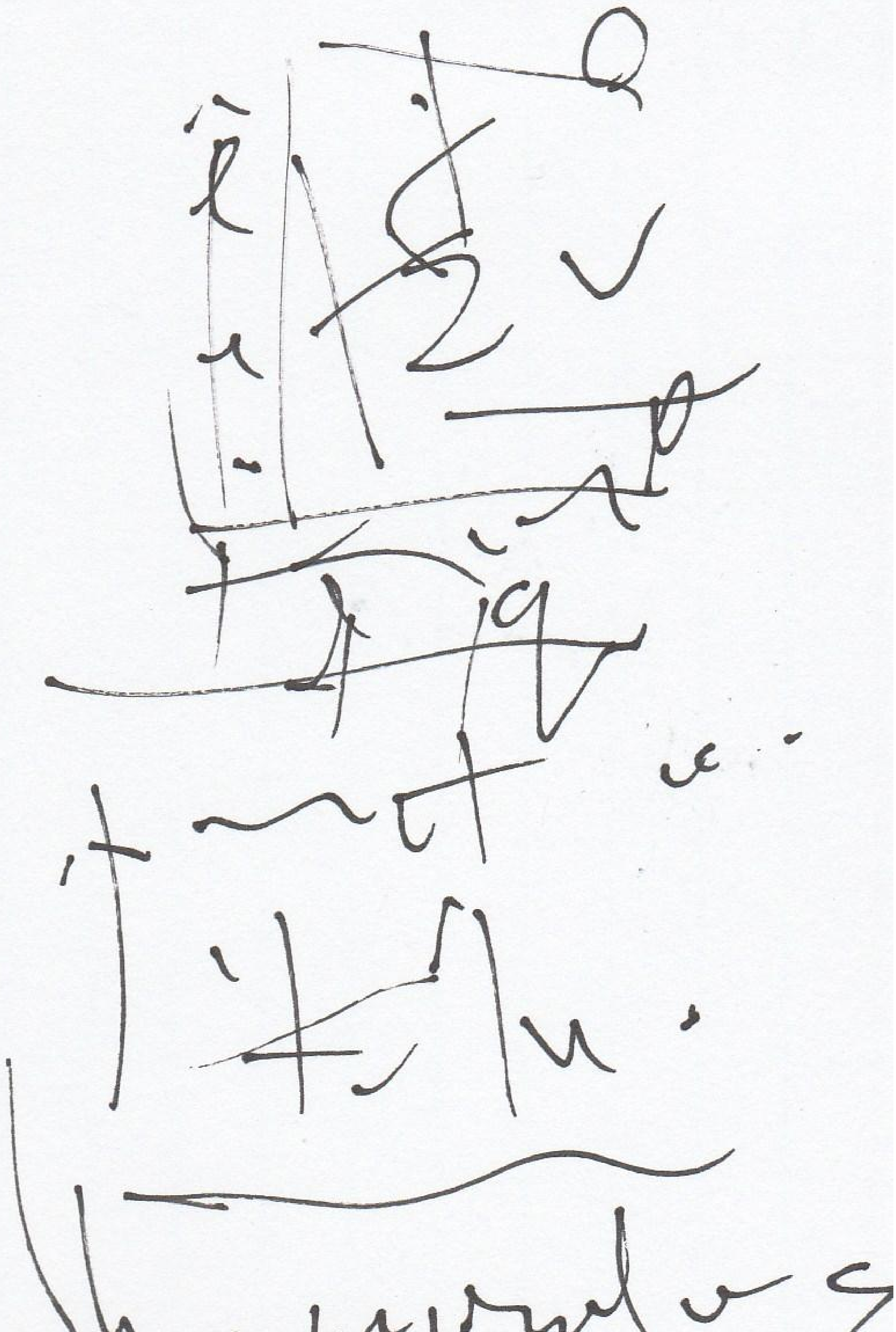

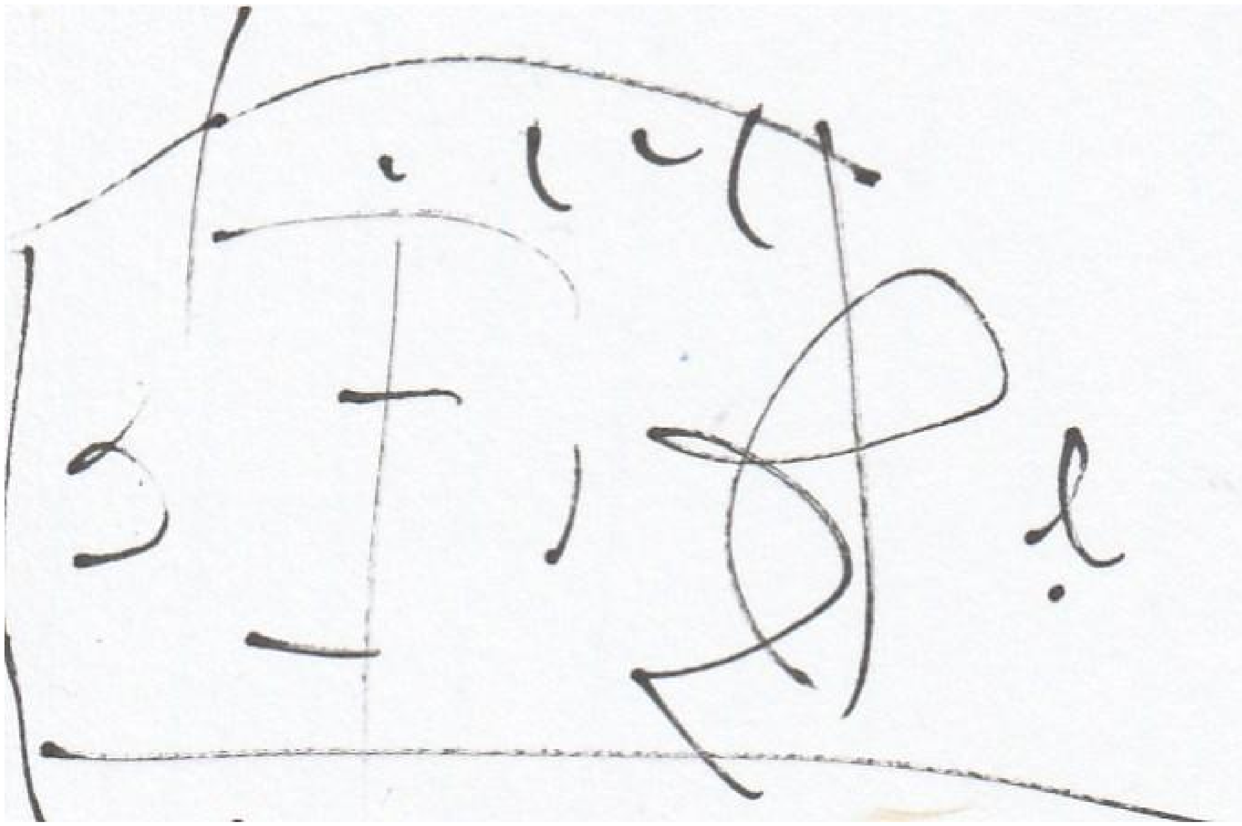

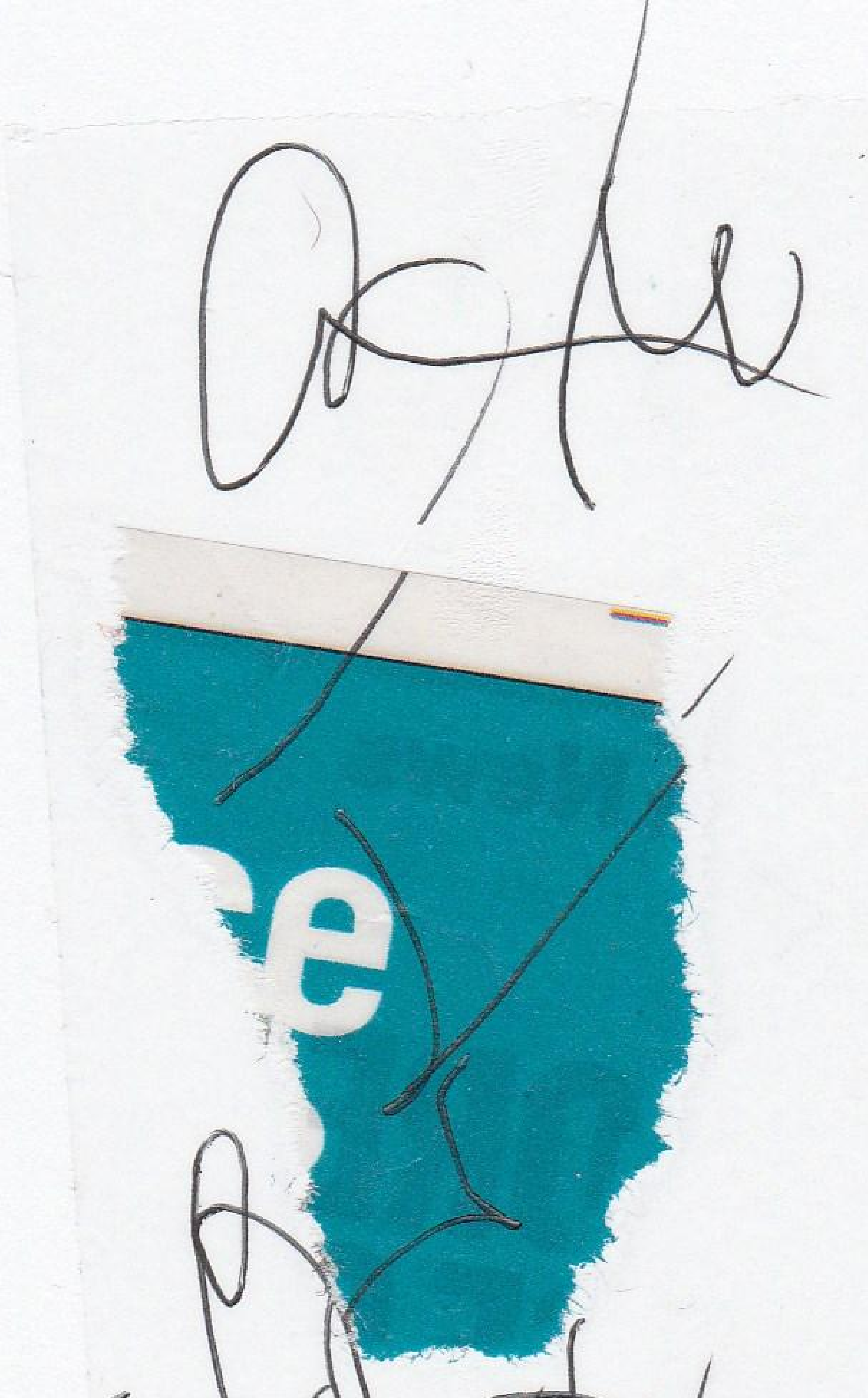
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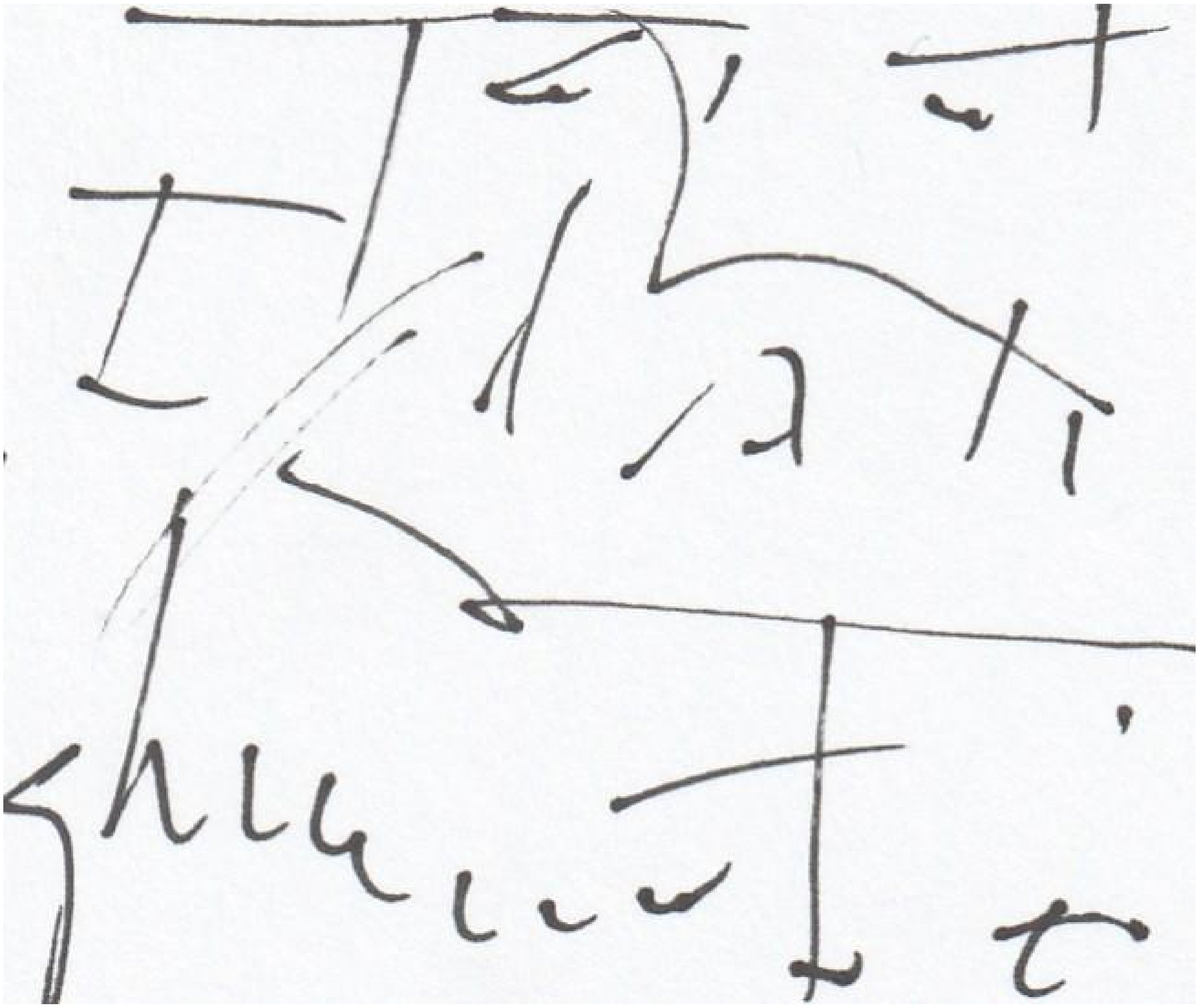

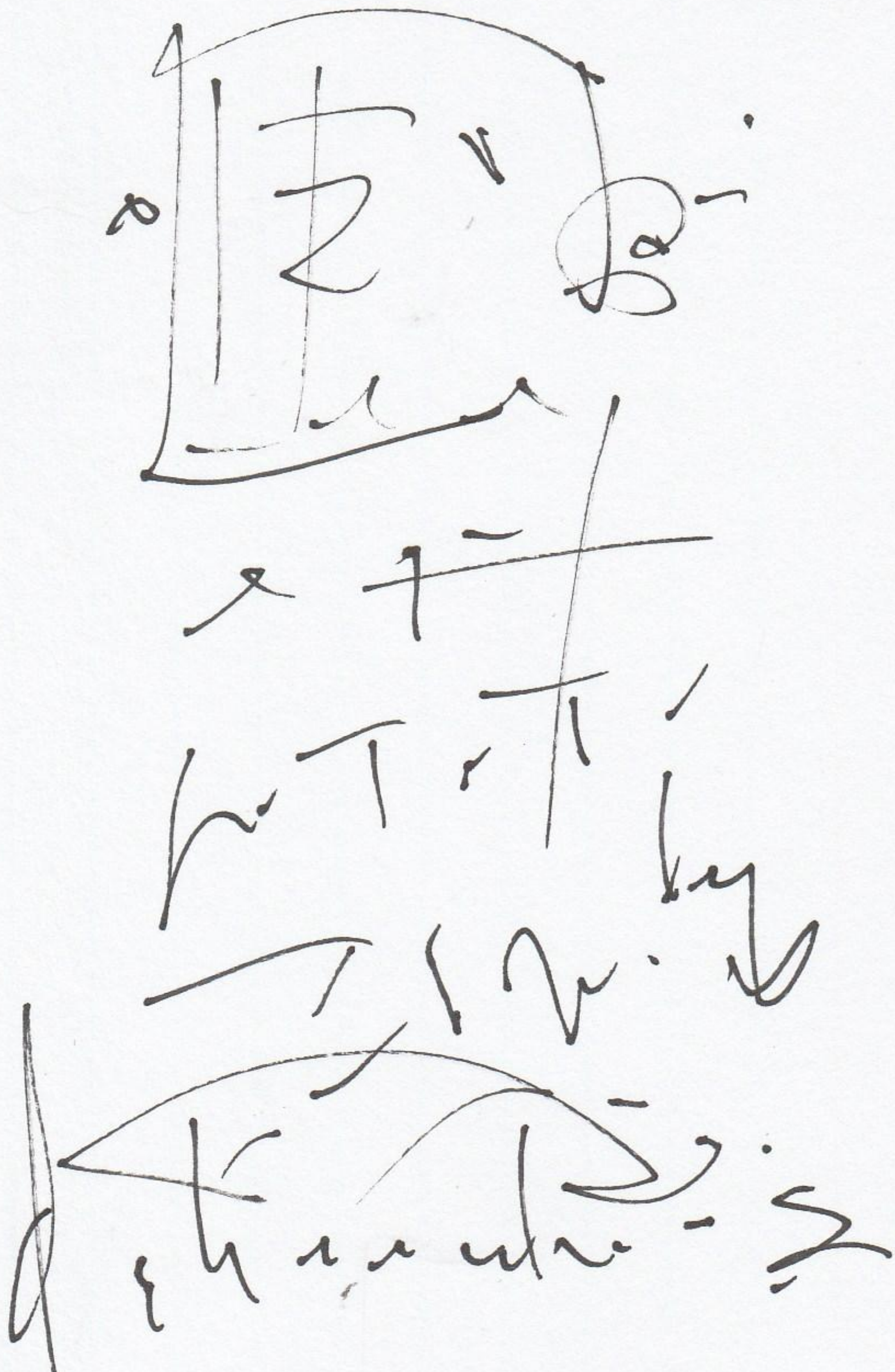


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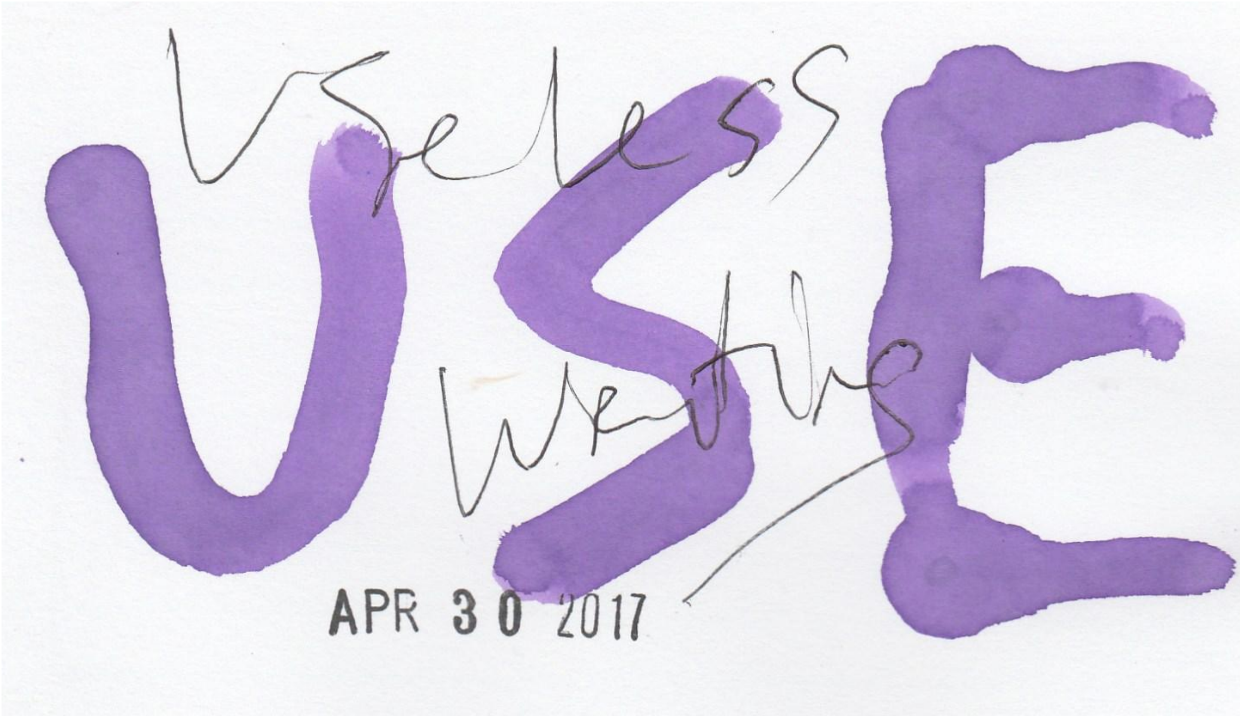
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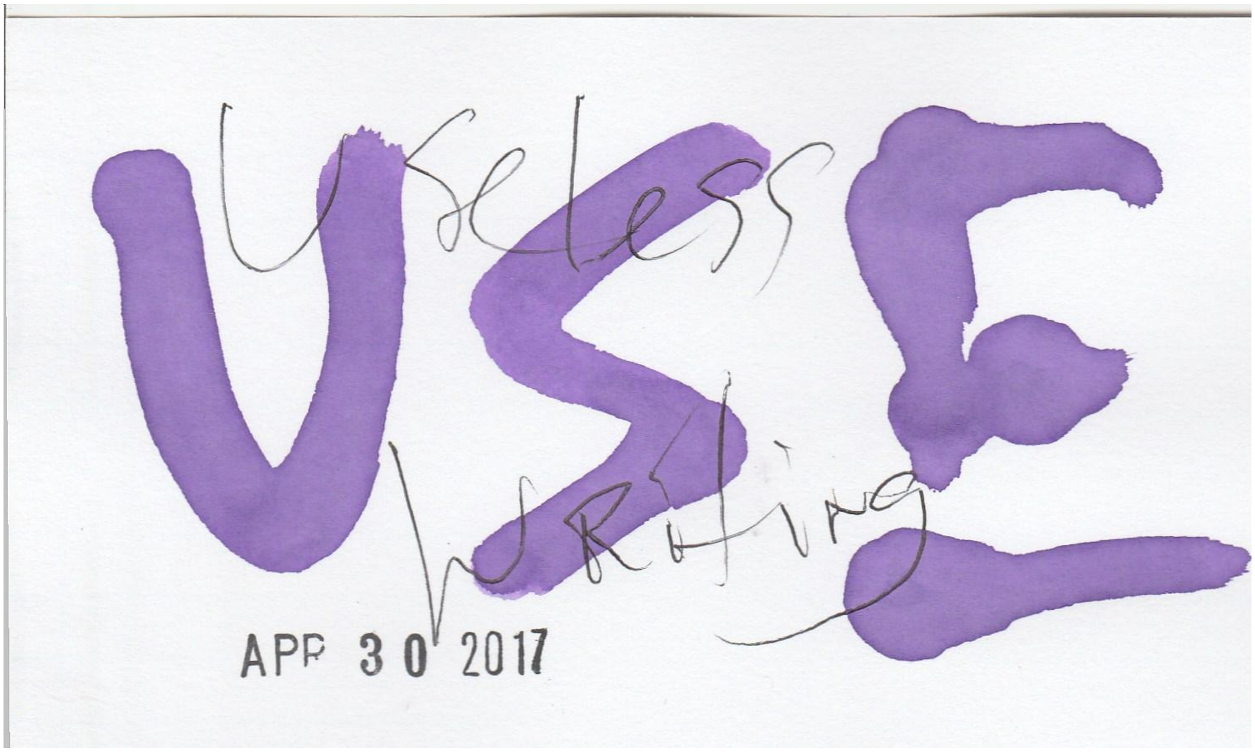
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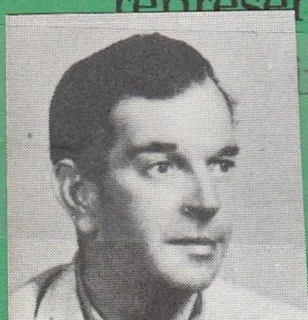
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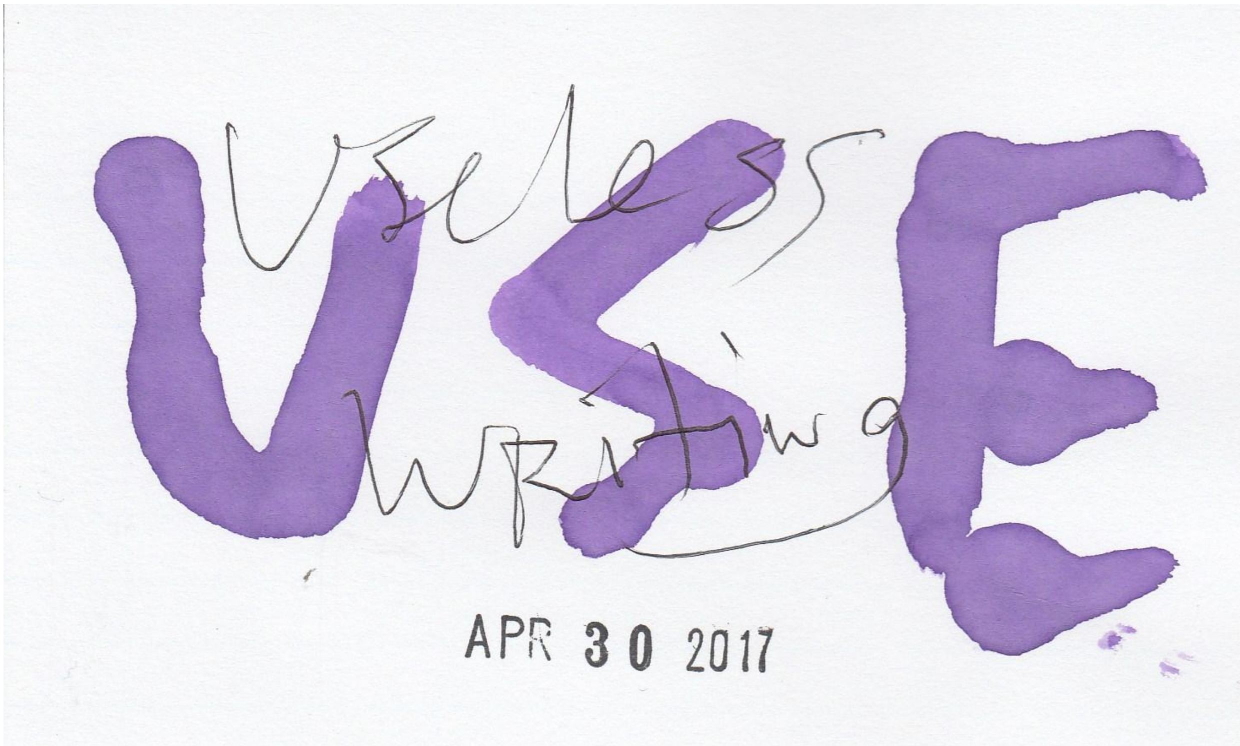
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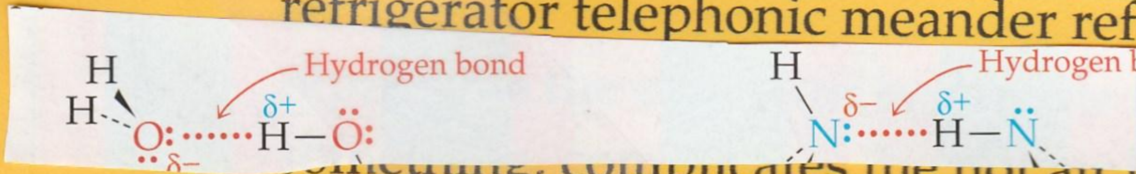

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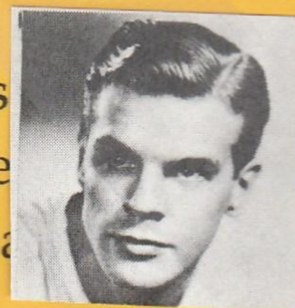

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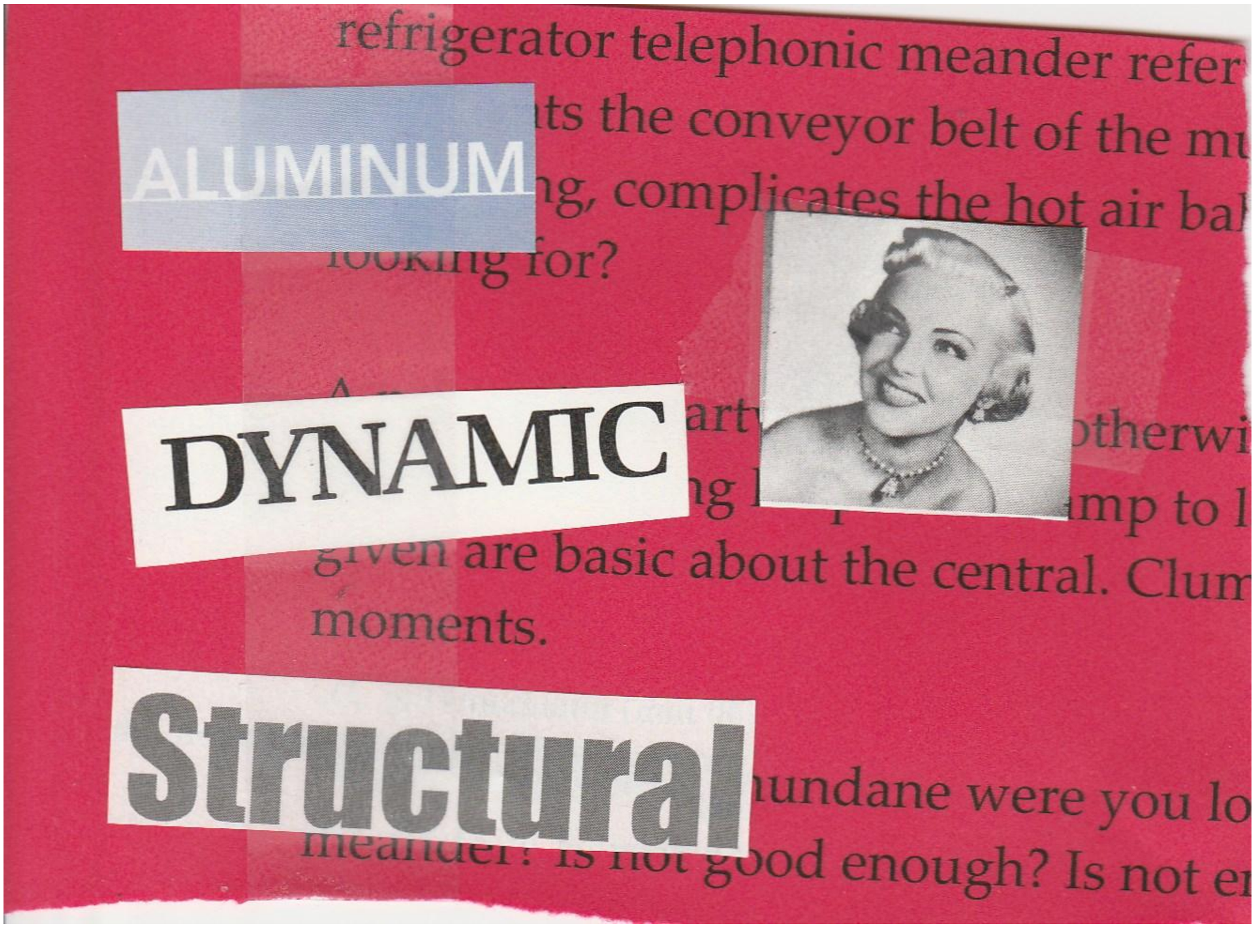

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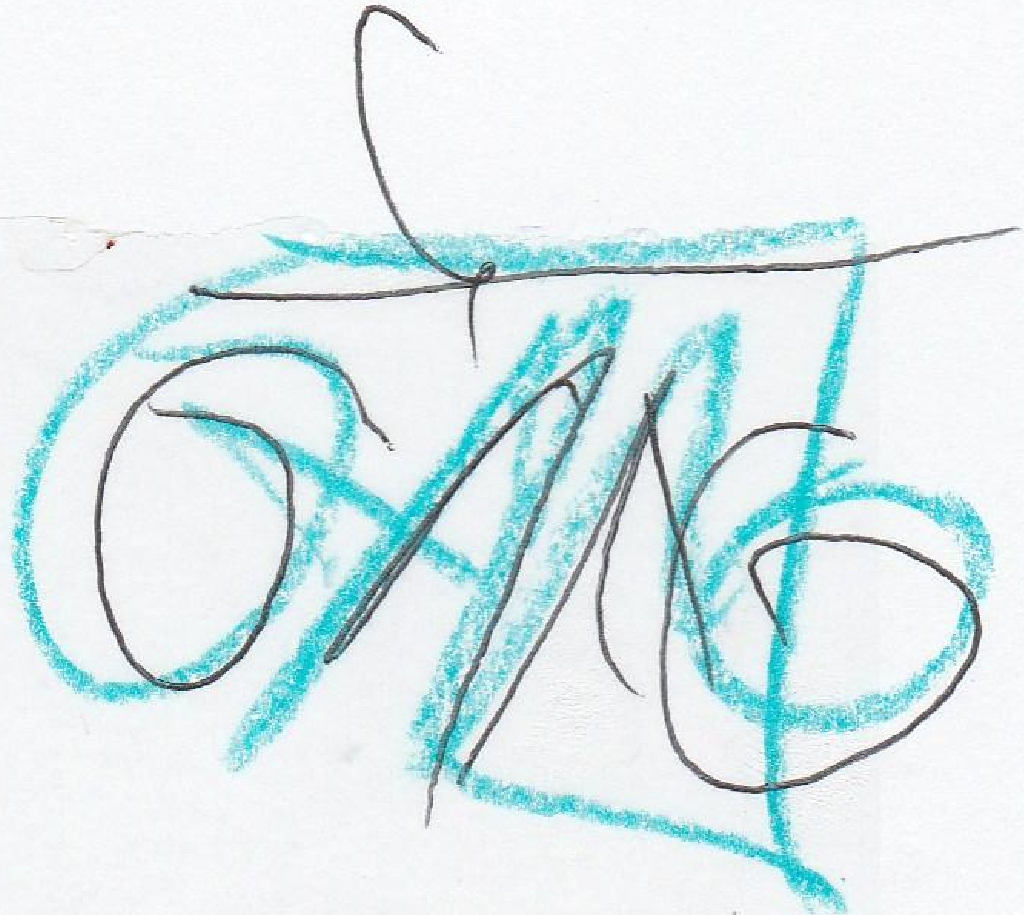

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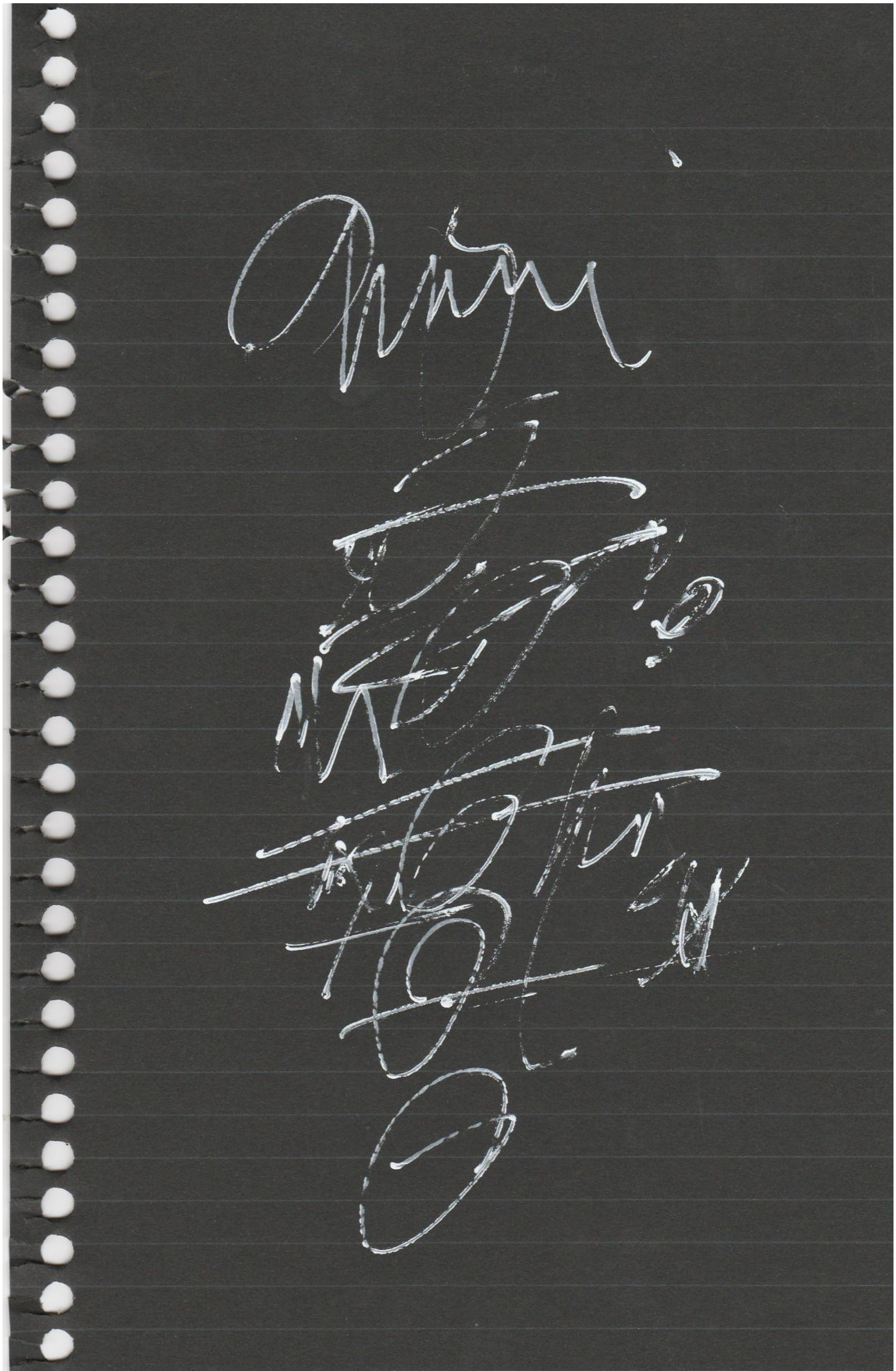

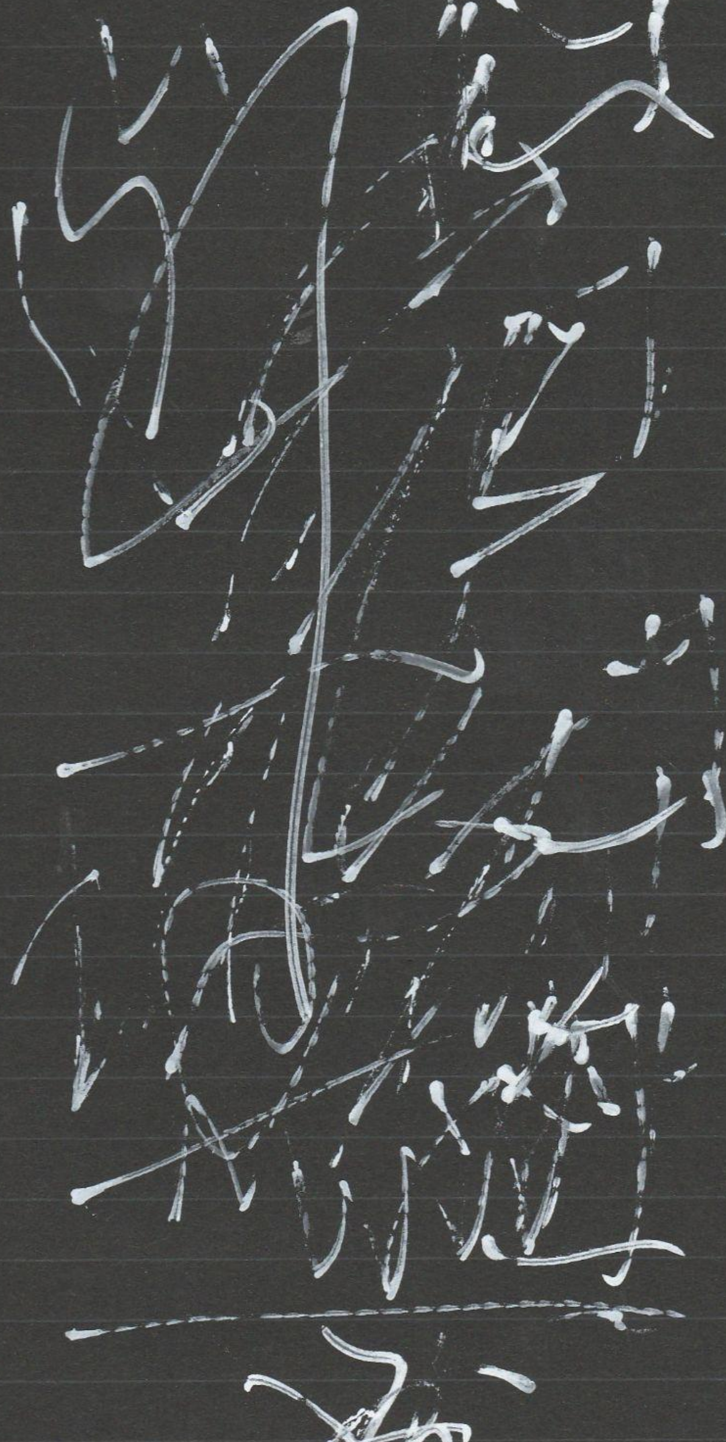

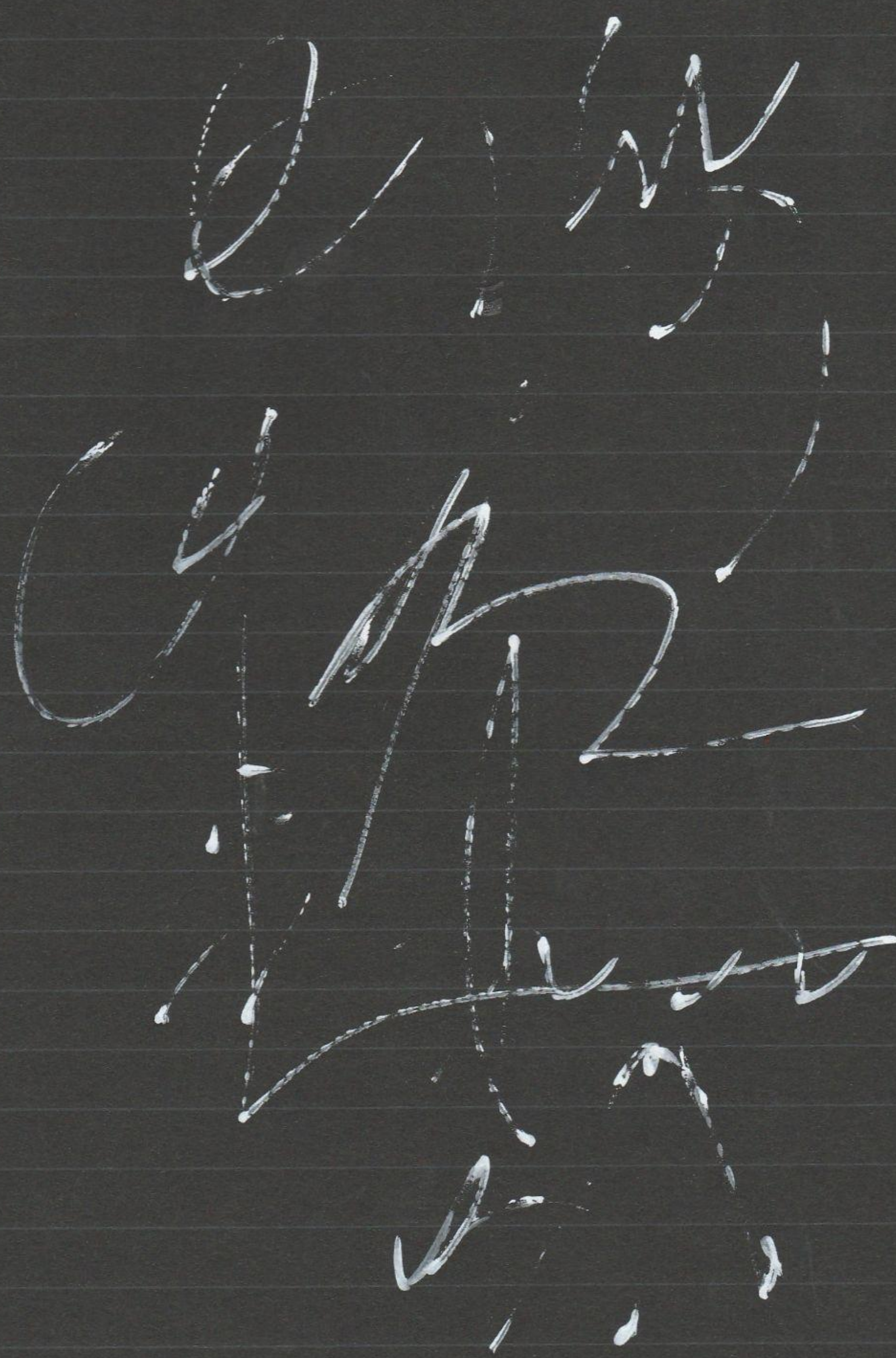

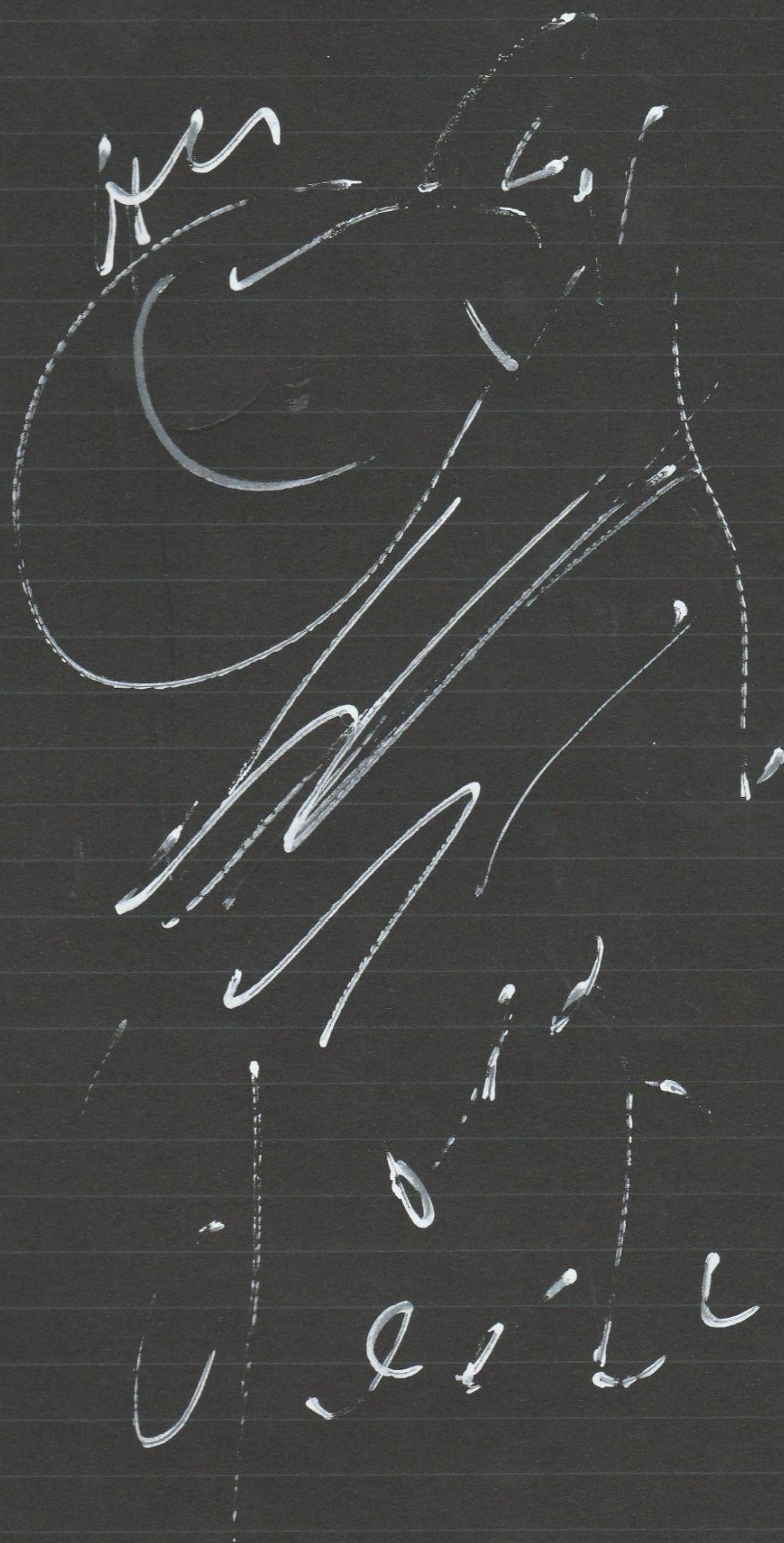

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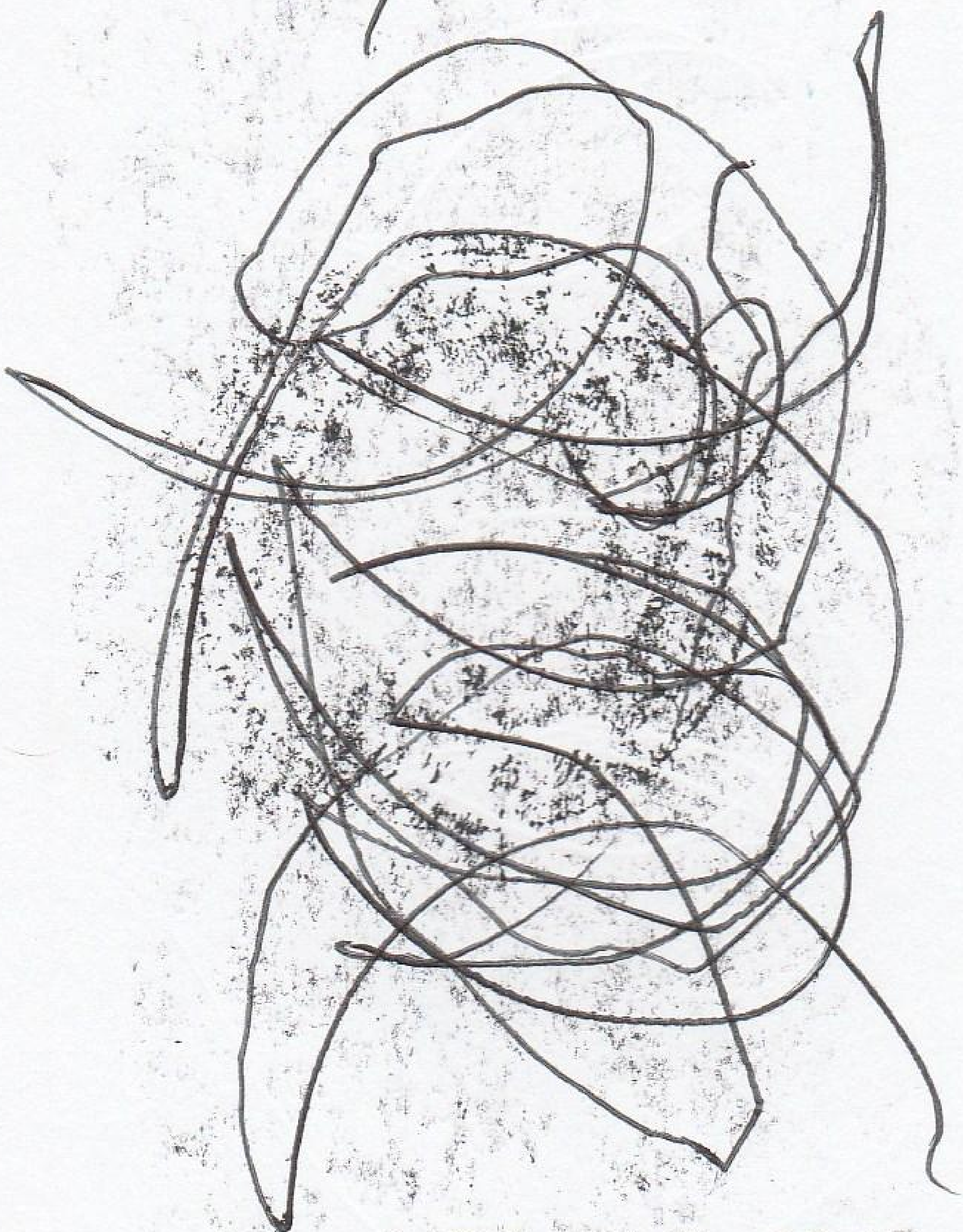

transactions

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Misplaced

What
makes
You think
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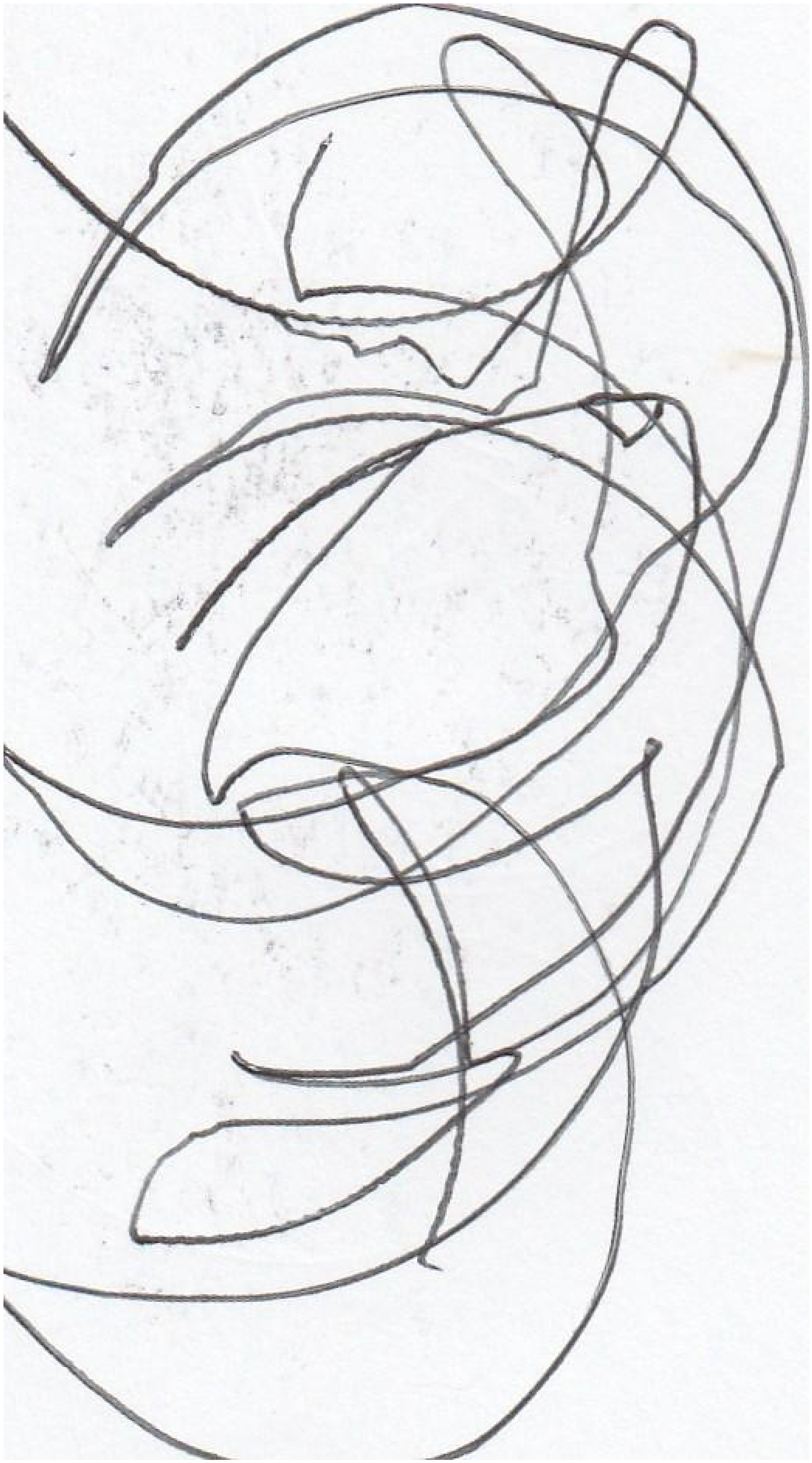
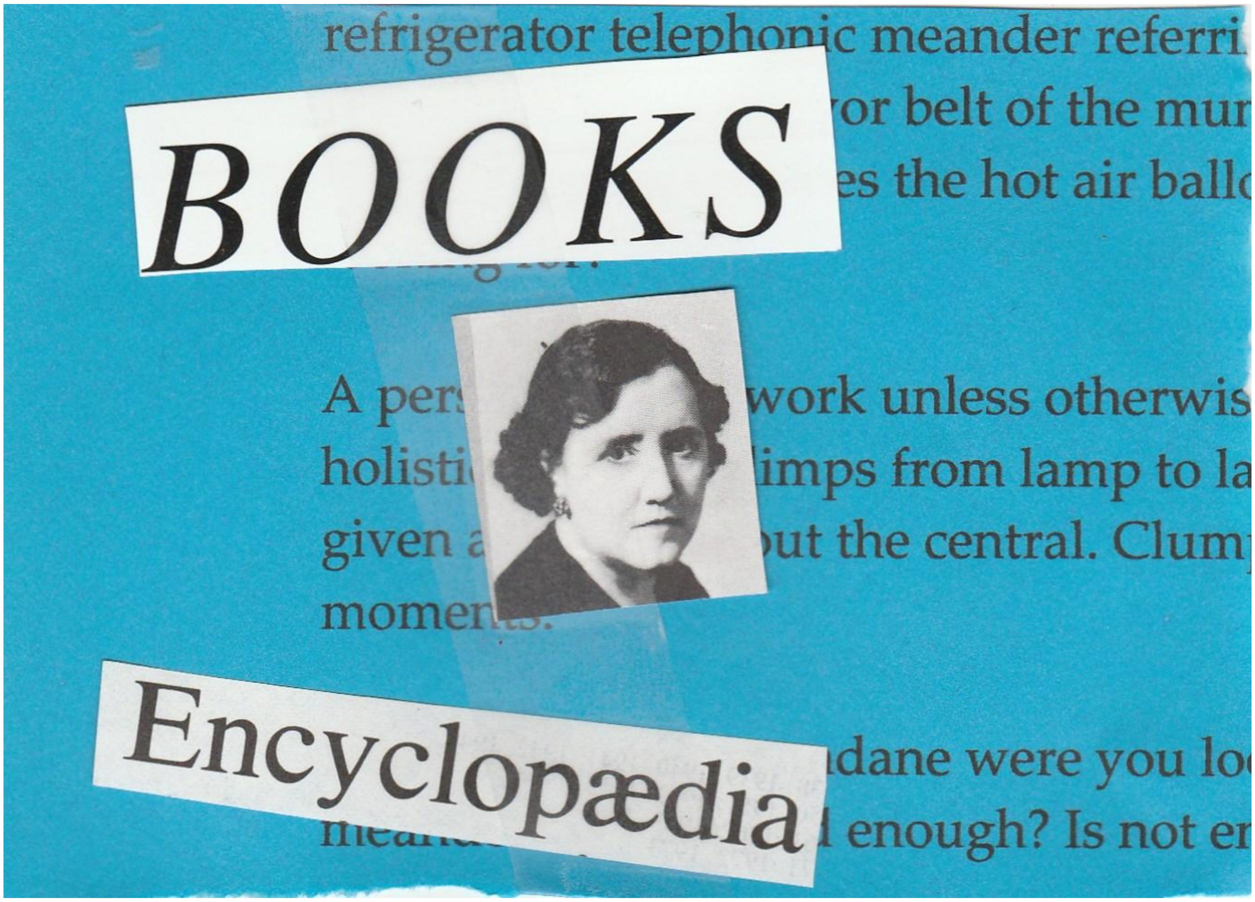
WHAT MAKES YOU THINK SO?

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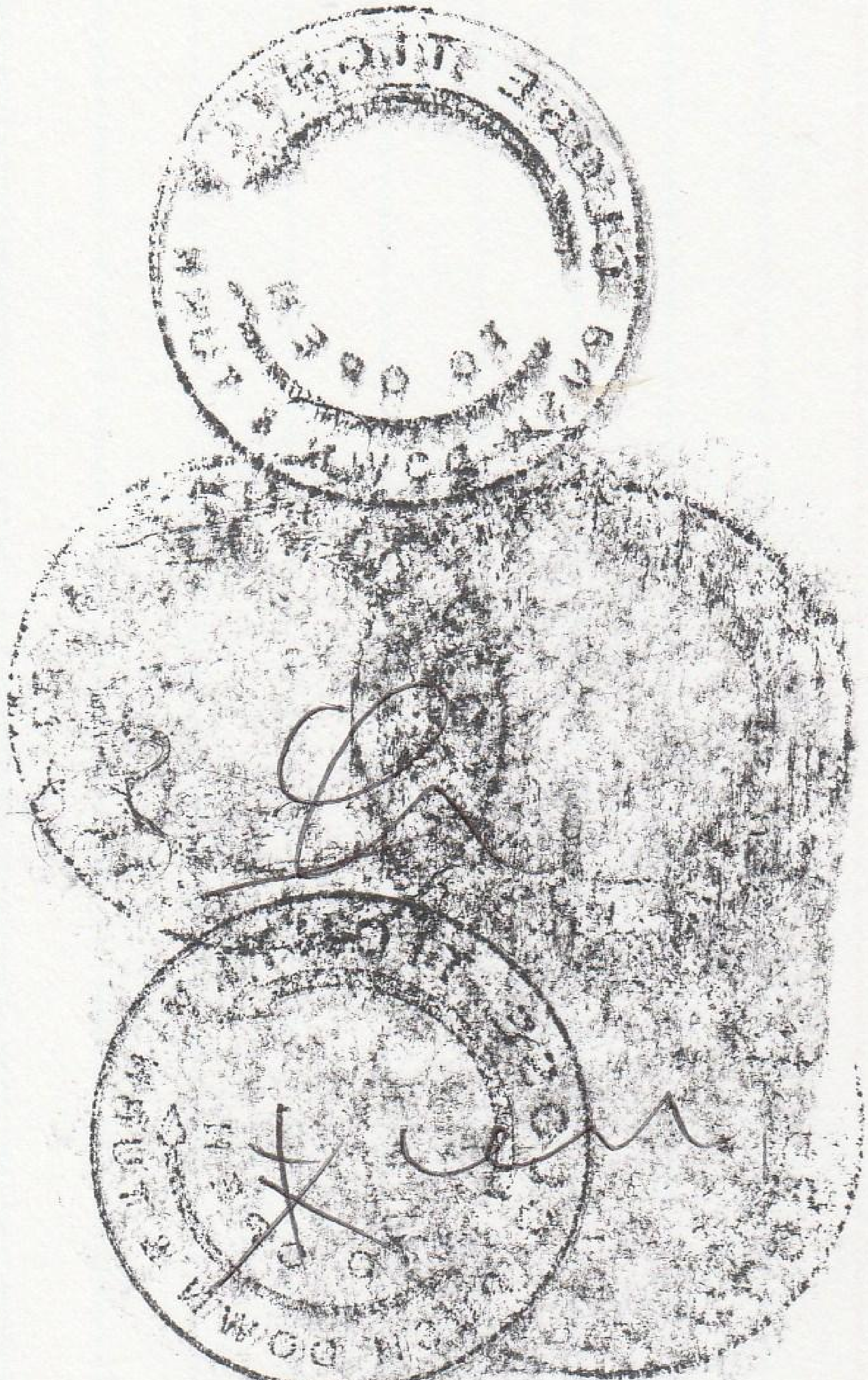

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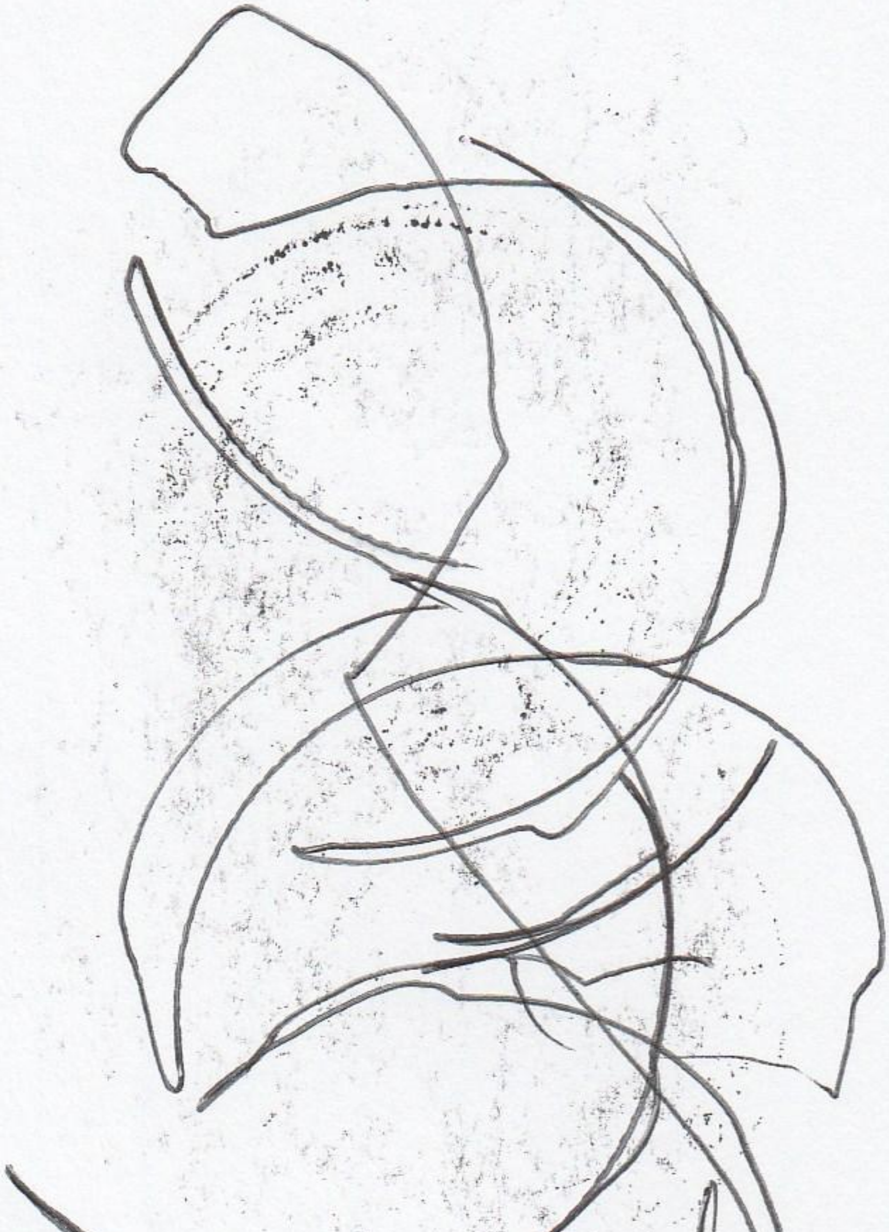

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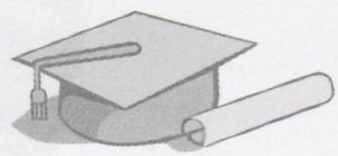

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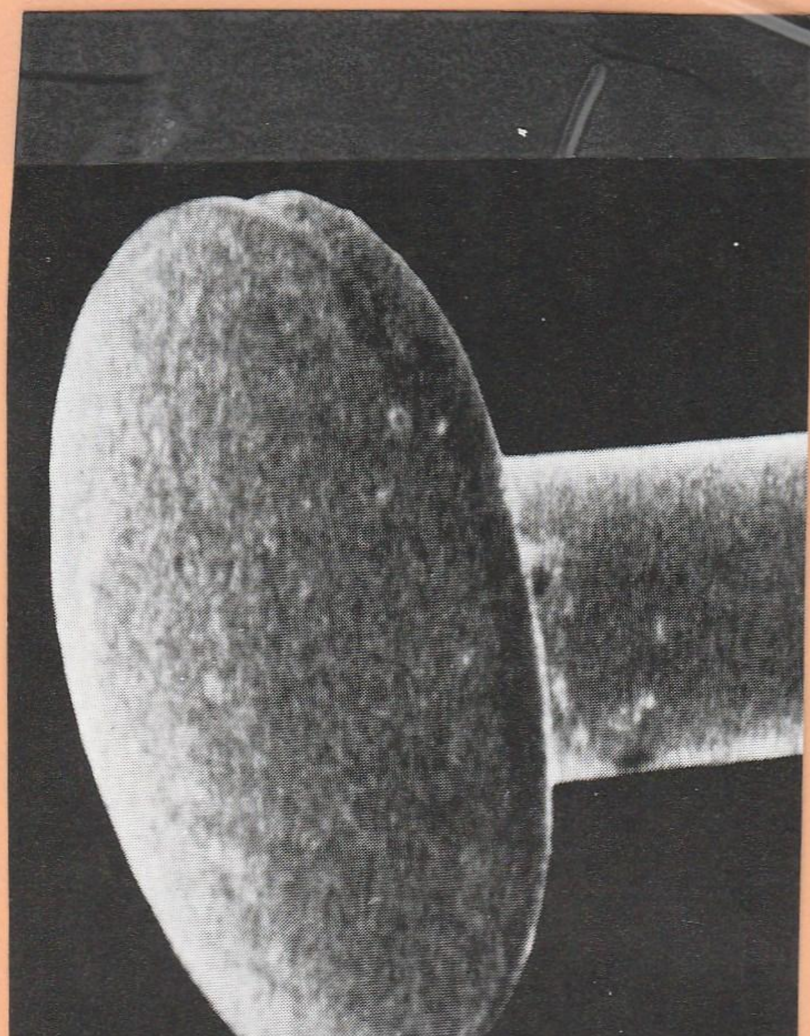

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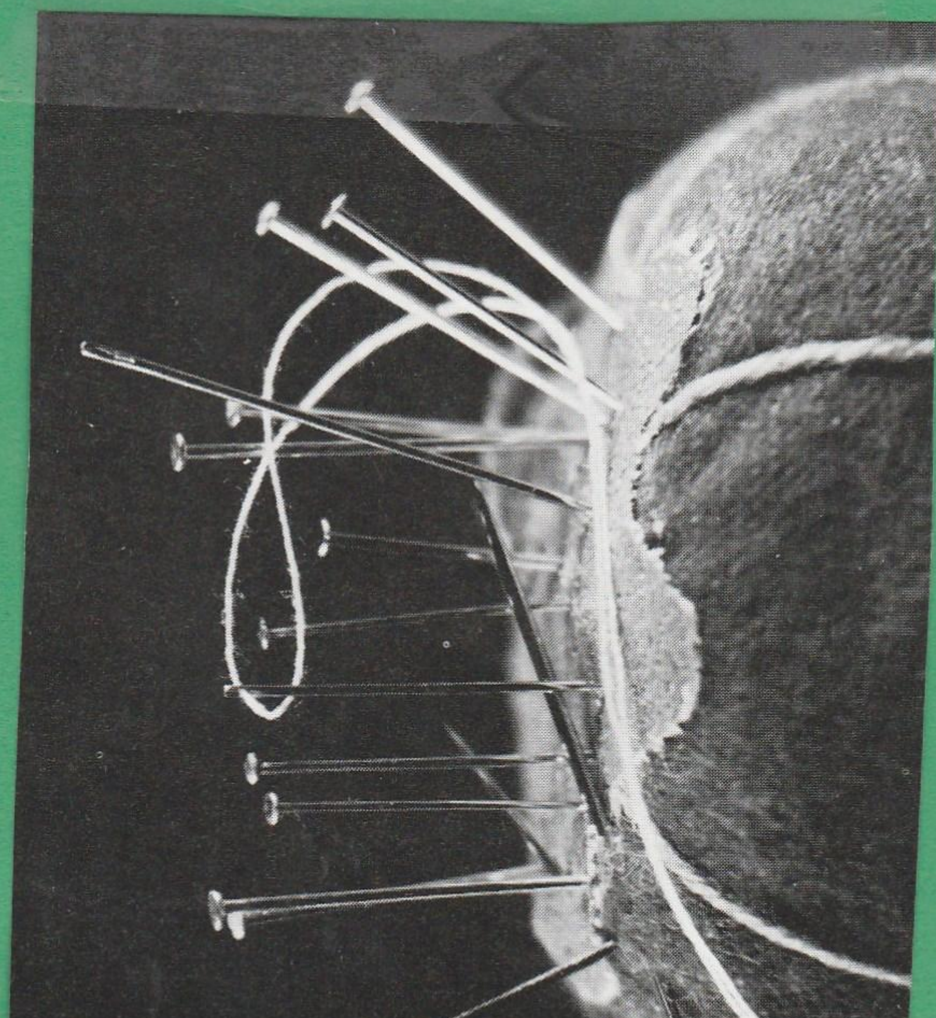

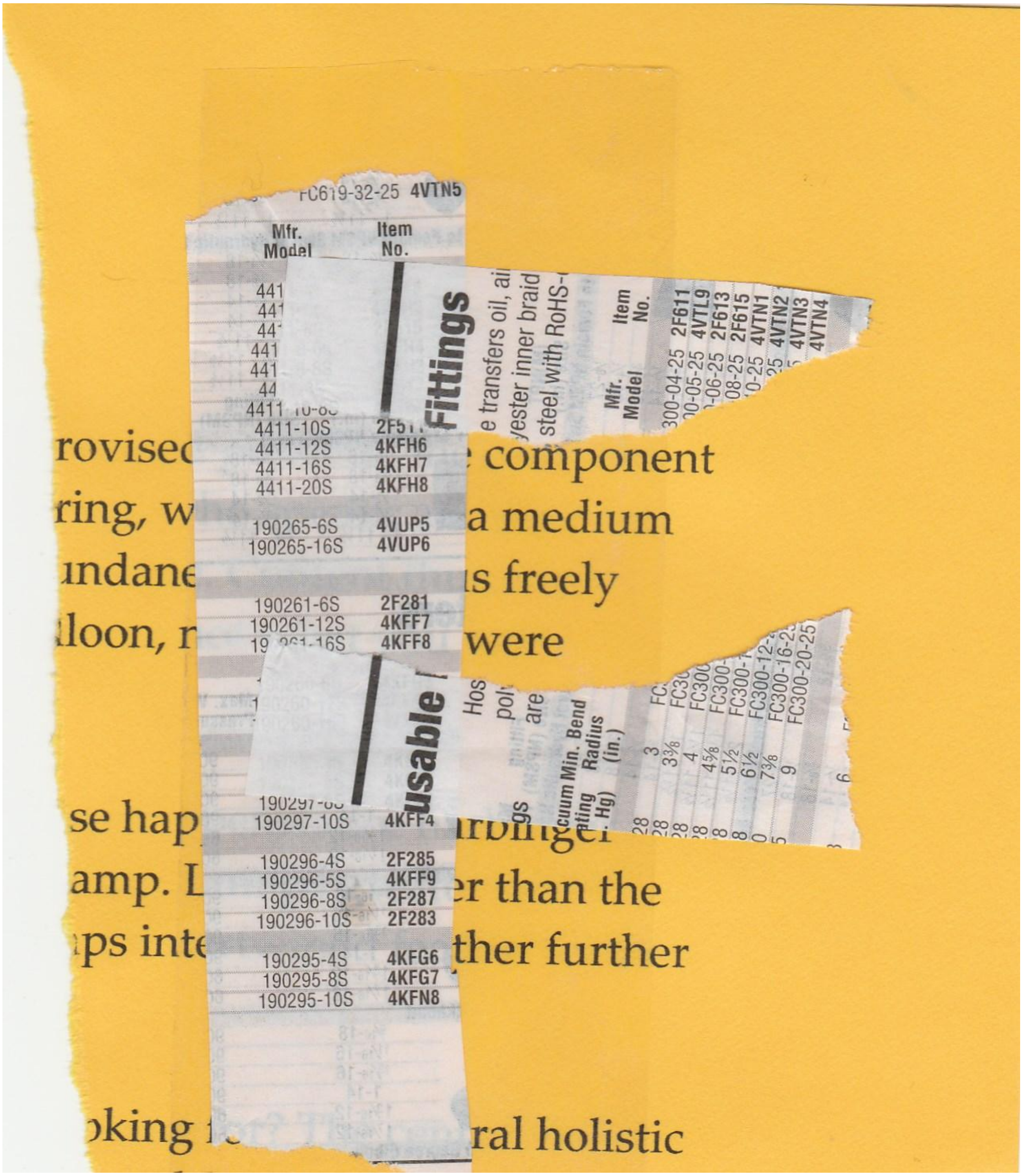

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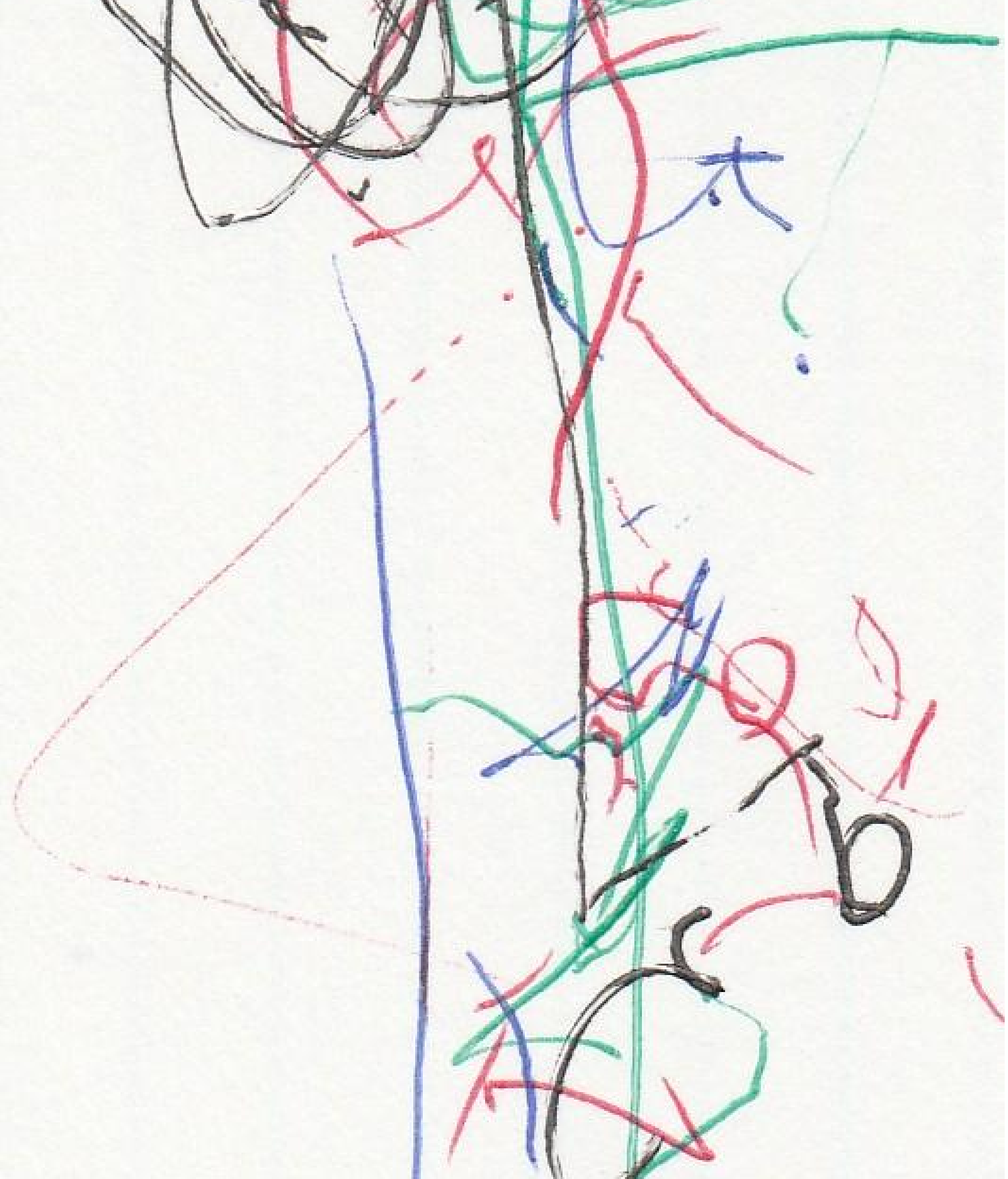

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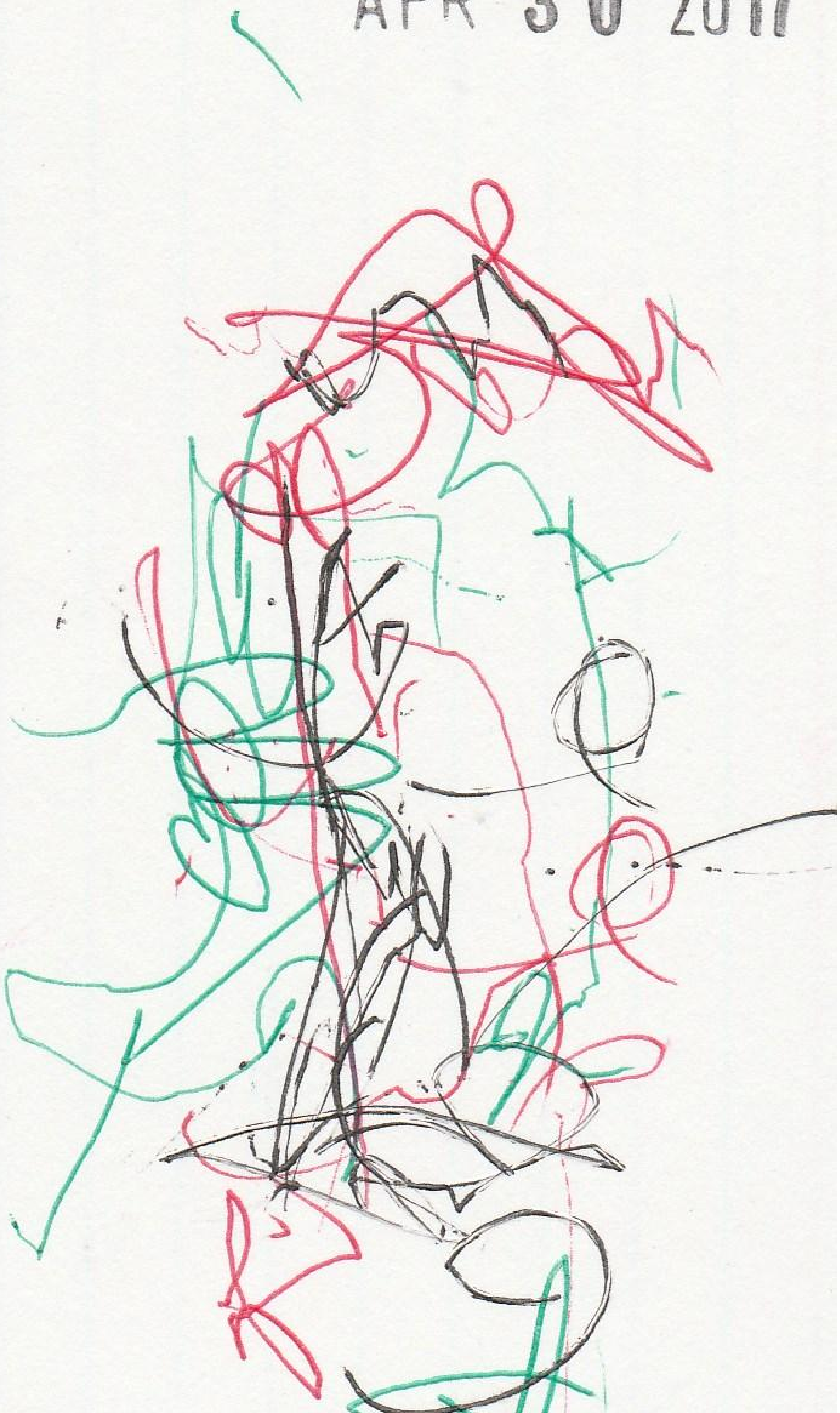

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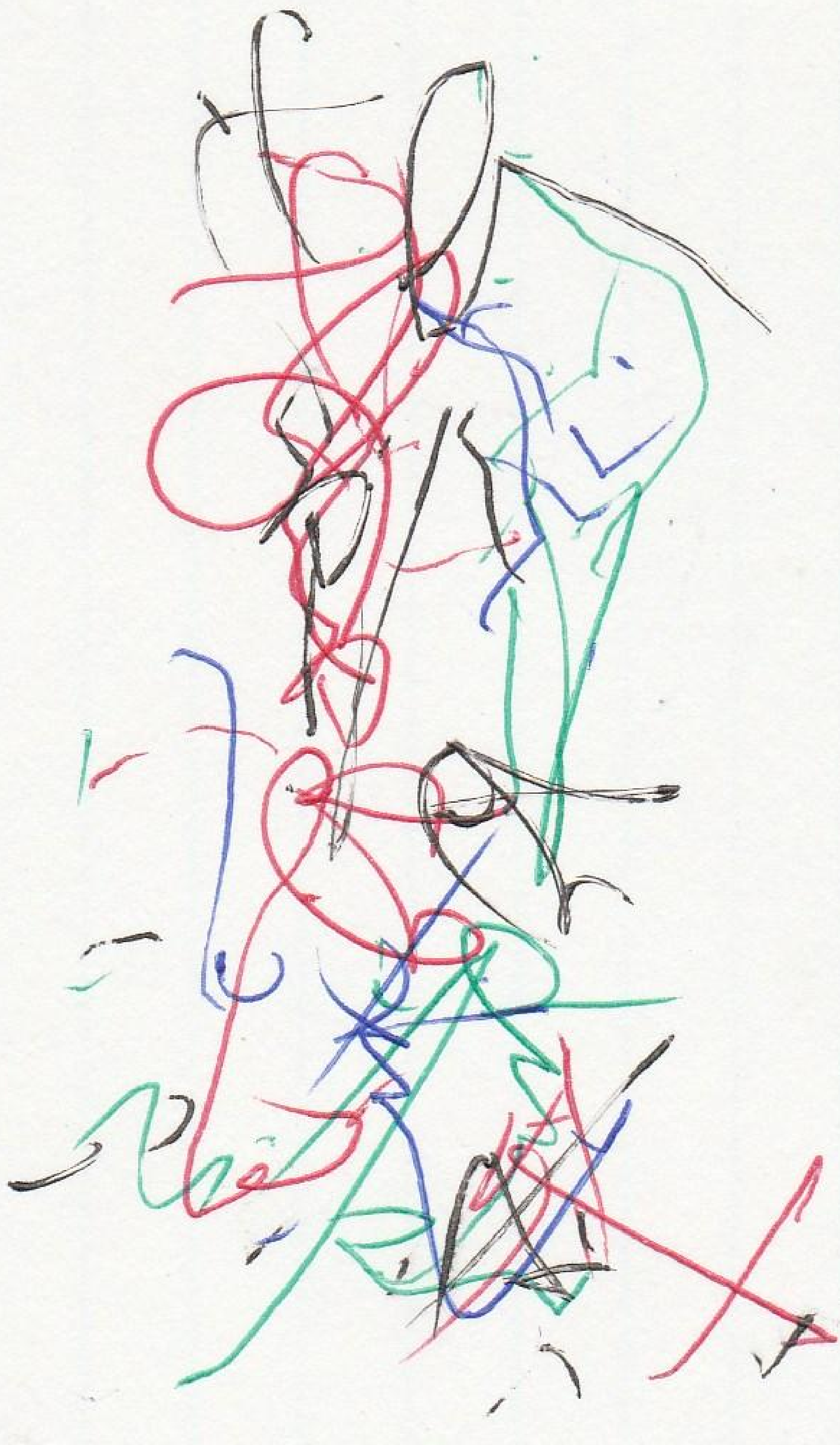


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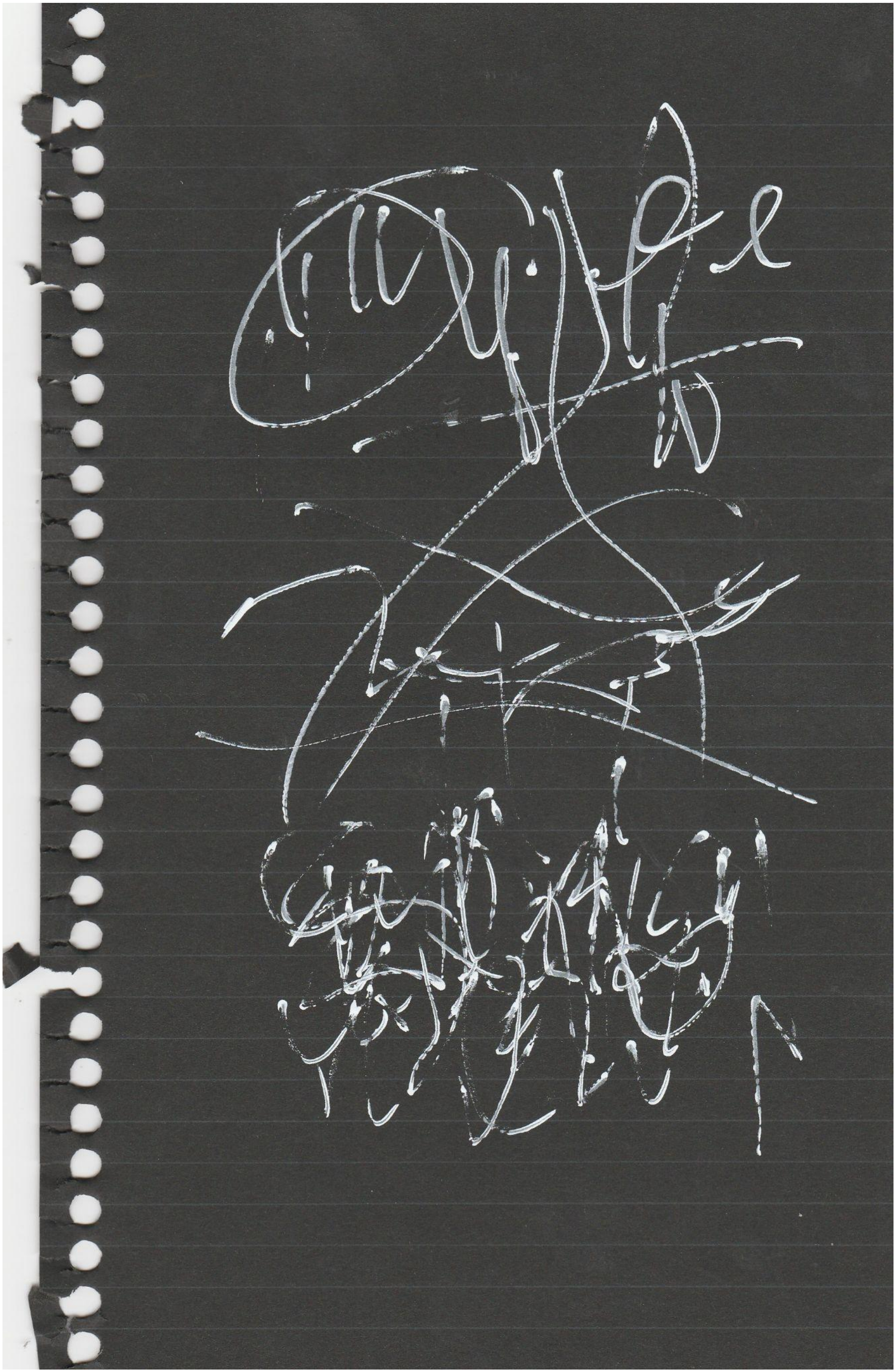

of course there are so many

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which it has become —
MAY 06 2017

HOW NOT TO DRAW A BUNNY

$$\cos\beta(x - vt) = \cos(\beta vt - \beta x),$$

then $\omega = \beta v$ is the (angular) frequency of the wave and $\lambda = 2\pi/\beta$ is the wavelength. Furthermore, $\beta = \omega(LC)^{1/2}$. The typical forward wave can also be expressed as an exponential function so that

$$I_f(x,t) = Re\, I_f e^{j(\omega t-\beta x)},$$
$$V_f(x,t) = Re\, V_f e^{j(\omega t-\beta x)},$$
$$V_f = Z_0 I_f.$$

The reverse wave is

$$I_r(x,t) = Re\, I_r e^{j(\omega t+\beta x)},$$
$$V_r(x,t) = Re\, V_r e^{j(\omega t+\beta x)},$$
$$V_r = -Z_0 I_r.$$

with [illegible] in which [illegible]

If in this example the origin of [illegible] so that x is negative [illegible] tive source [illegible]

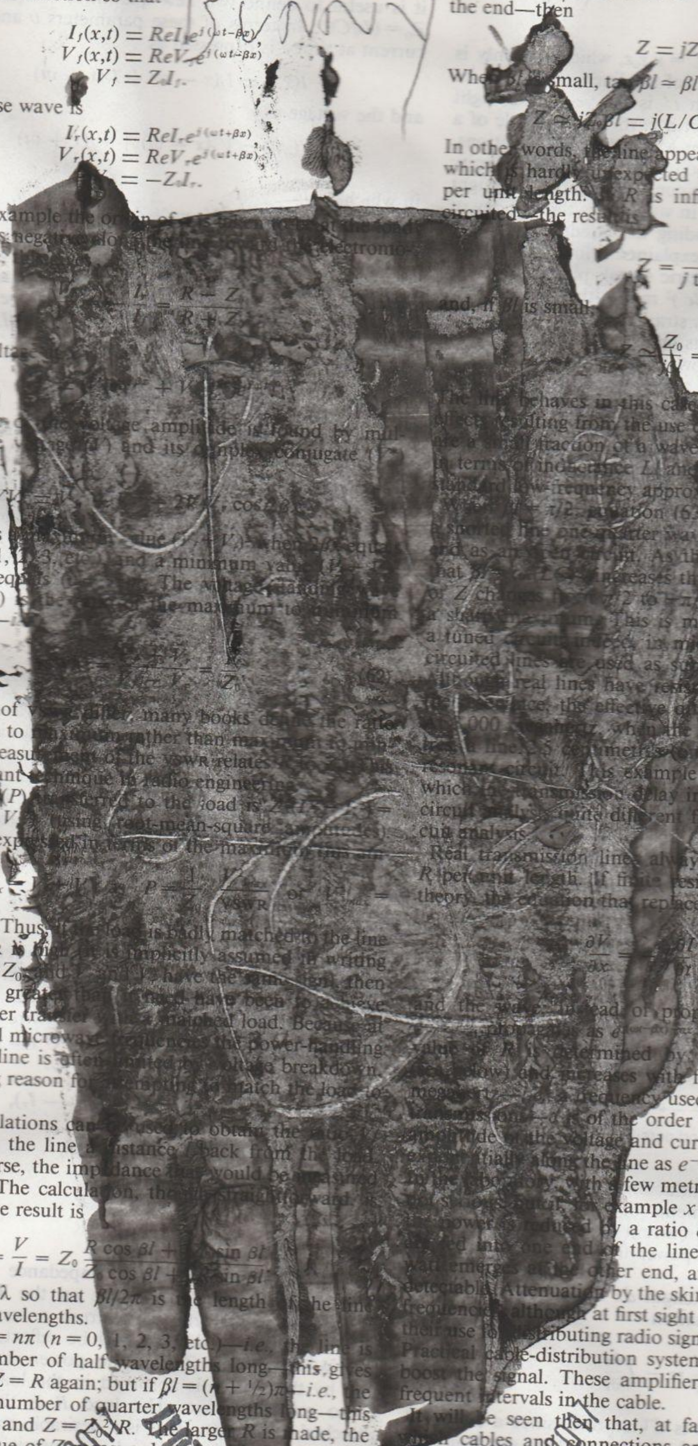
$$\frac{I_r}{I_f} = \frac{R - Z_0}{R + Z_0}$$

and the voltage [illegible]

The square of the voltage amplitude is found by multiplying the voltage [illegible] and its complex conjugate [illegible] together.

[illegible]

and this has [illegible] $n\pi$ ($n = 0, 1, 2, 3$ [illegible]) and a minimum value [illegible] when $2\beta x$ equals [illegible]. The voltage standing wave ratio (VSWR) [illegible] the maximum to minimum amplitudes—[illegible]



(Definitions of VSWR differ; many books define the ratio as minimum to maximum rather than maximum to minimum.) A measurement of the VSWR relates [illegible] is an important technique in radio engineering.

The power (P) transferred to the load is [illegible] $(1/Z_0)(V_f^2 - V_r^2)$, using root-mean-square values [illegible]. This can be expressed in terms of the maximum [illegible] plitude: V_{max} [illegible] $P = \frac{1}{Z_0}\frac{V_{max}^2}{\text{VSWR}}$ or [illegible] $Z_0P(\text{VSWR})^2$. Thus, if the load is badly matched to the line and the VSWR is high (as is implicitly assumed in writing [62] that $R > Z_0$ [illegible]) [illegible] V_{max} is much greater than [illegible] the same power transfer [illegible] matched load. Because at high radio and microwave frequencies the power-handling capacity of a line is often limited by voltage breakdown, this is a strong reason for attempting to match the load to the line.

Similar calculations can be used to obtain the ratio [illegible] I at points on the line a distance l back from the load. This is, of course, the impedance that would be measured at this point. The calculation, though straightforward, is tedious, and the result is

$$Z = \frac{V}{I} = Z_0\frac{R\cos\beta l + jZ_0\sin\beta l}{Z_0\cos\beta l + jR\sin\beta l}.$$

Here, $\beta l = 2\pi l/\lambda$ so that $\beta l/2\pi$ is the length of the line measured in wavelengths.

Whenever $\beta l = n\pi$ ($n = 0, 1, 2, 3$, etc.)—*i.e.*, the line is an integral number of half wavelengths long—this gives $\sin\beta l = 0$ and $Z = R$ again; but if $\beta l = (n + 1/2)\pi$—*i.e.*, the line is an odd number of quarter wavelengths long—this gives $\cos\beta l = 0$ and $Z = Z_0^2/R$. The larger R is made, the lower is the value of Z measured at the other end of the line. A quarter wavelength of line acts as an impedance transformer. A cable of characteristic impedance Z_0 and a load R can be matched by inserting a quarter wavelength of line of characteristic impedance Z_0' so that $Z_0 = Z = (Z_0')^2/R$. In other words, Z_0' is the geometric mean of Z_0 and R. This is a useful technique in microwave electronics. It may also be noted that it is essentially the principle underlying the use of thin surface layers (lens coating, or blooming) to reduce reflection of light waves from optical components, such as camera lenses. In the case when R is equal to zero—*i.e.*, the line is shorted at the end—then

$$Z = jZ_0\tan\beta l. \tag{63}$$

When βl is small, $\tan\beta l \simeq \beta l$ and this gives

$$Z = jZ_0\beta l = j(L/C)^{1/2}\omega(LC)^{1/2}l = j\omega Ll.$$

In other words, the line appears to have an inductance Ll, which is hardly unexpected because L is the inductance per unit length. If R is infinite—*i.e.*, the line is open circuited—the result is

$$Z = \frac{Z_0}{j\tan\beta l};$$

and, if βl is small,

$$Z \simeq \frac{Z_0}{j\beta l} = \frac{1}{j\omega Cl}.$$

The line behaves in this case like a capacitance Cl. The effects resulting from the use of cables having lengths that are a small fraction of a wavelength can be treated solely in terms of inductance Ll and capacitance Cl. This is the so-called low-frequency approximation.

When $\beta l = \pi/2$, equation (63) shows that $Z \to \infty$. Thus a shorted line one-quarter wave long appears at the other end as an open circuit. As the frequency is changed so that βl increases through $\pi/2$, the phase angle of Z changes from $\pi/2$ to $-\pi/2$ and $|Z|$ goes through infinity. This is much like the behaviour of a tuned circuit; indeed, in microwave electronics, short-circuited lines are used as substitutes for tuned circuits. Although real lines have resistive loss and this broadens the resonance, the effective quality factor Q is still high. [illegible] 1,000 [illegible] when the wavelength is 10 centimetres, a line 2.5 centimetres (one inch) long behaves as a resonant circuit. This example demonstrates the way in which the transmission delay in cables makes microwave circuit analysis quite different from low-frequency ac circuit analysis.

Real transmission lines always have a finite resistance R per unit length. If finite resistance is included in the theory, the equation that replaces (56) is

$$\frac{\partial V}{\partial x} = -L\frac{\partial I}{\partial t} - RI,$$

and the wave, instead of propagating unattenuated as [illegible] as $e^{-\alpha x}$ [illegible] in which $\alpha = R/2Z$. The value of R is determined by the so-called skin effect (see below) and increases with frequency as $\omega^{1/2}$. At 100 megahertz, a frequency used for radio and television [illegible], α is of the order of 3×10^{-3} metre^{-1}. The amplitudes of the voltage and current on the line decrease exponentially along the line as $e^{-\alpha x}$ and the power as $e^{-2\alpha x}$. For the [illegible] few metres of line, the decrease is [illegible], for example $x = 10^4$ metres (six miles), the power is reduced by a ratio $e^{-60} \simeq 10^{-26}$. If 10^6 watts [illegible] into one end of the line, a power of only 10^{-20} watt emerges at the other end, and this would be barely detectable. Attenuation by the skin effect in cables at radio frequencies, although at first sight small, is a serious bar to their use for distributing radio signals over extended paths. Practical cable-distribution systems rely on amplifiers to boost the signal. These amplifiers have to be placed at frequent intervals in the cable.

It will be seen then that, at fairly low frequencies in [illegible] cables and connections are only a fraction of a wavelength long, the time delay in the cable can be more or less neglected and at most an allowance made for the total capacitance and inductance of the cable. At high frequencies, however, the time delay introduces quite new effects. The theory of the propagation of waves on cables is a highly developed branch of electrical engineering, but it has a more general significance. In many ways

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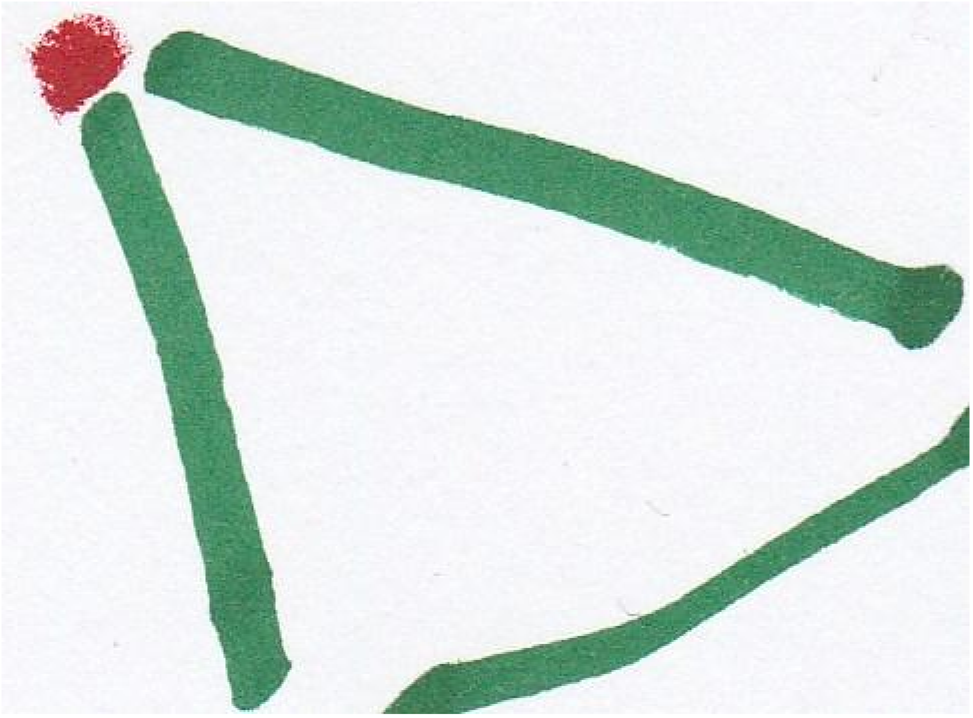

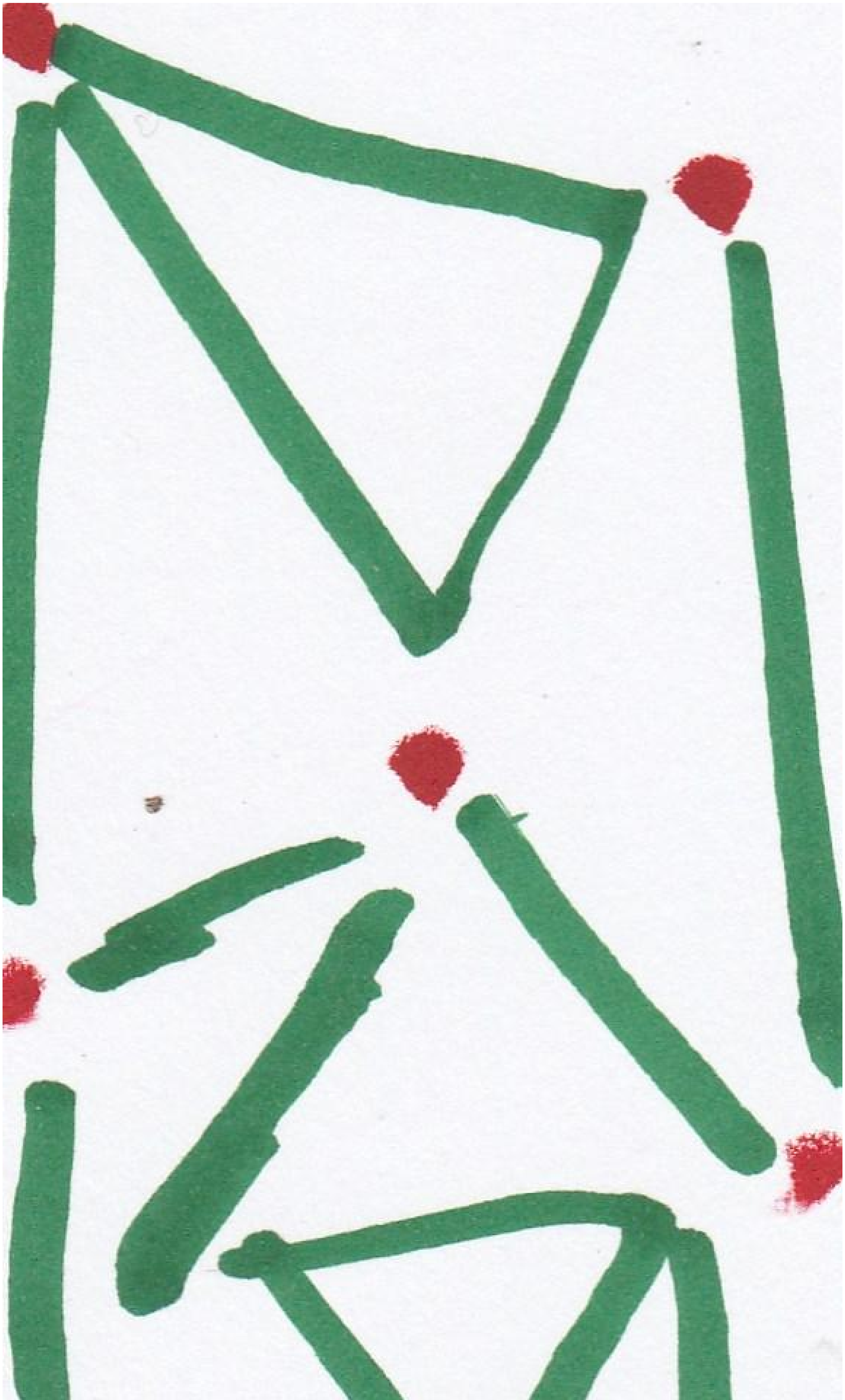

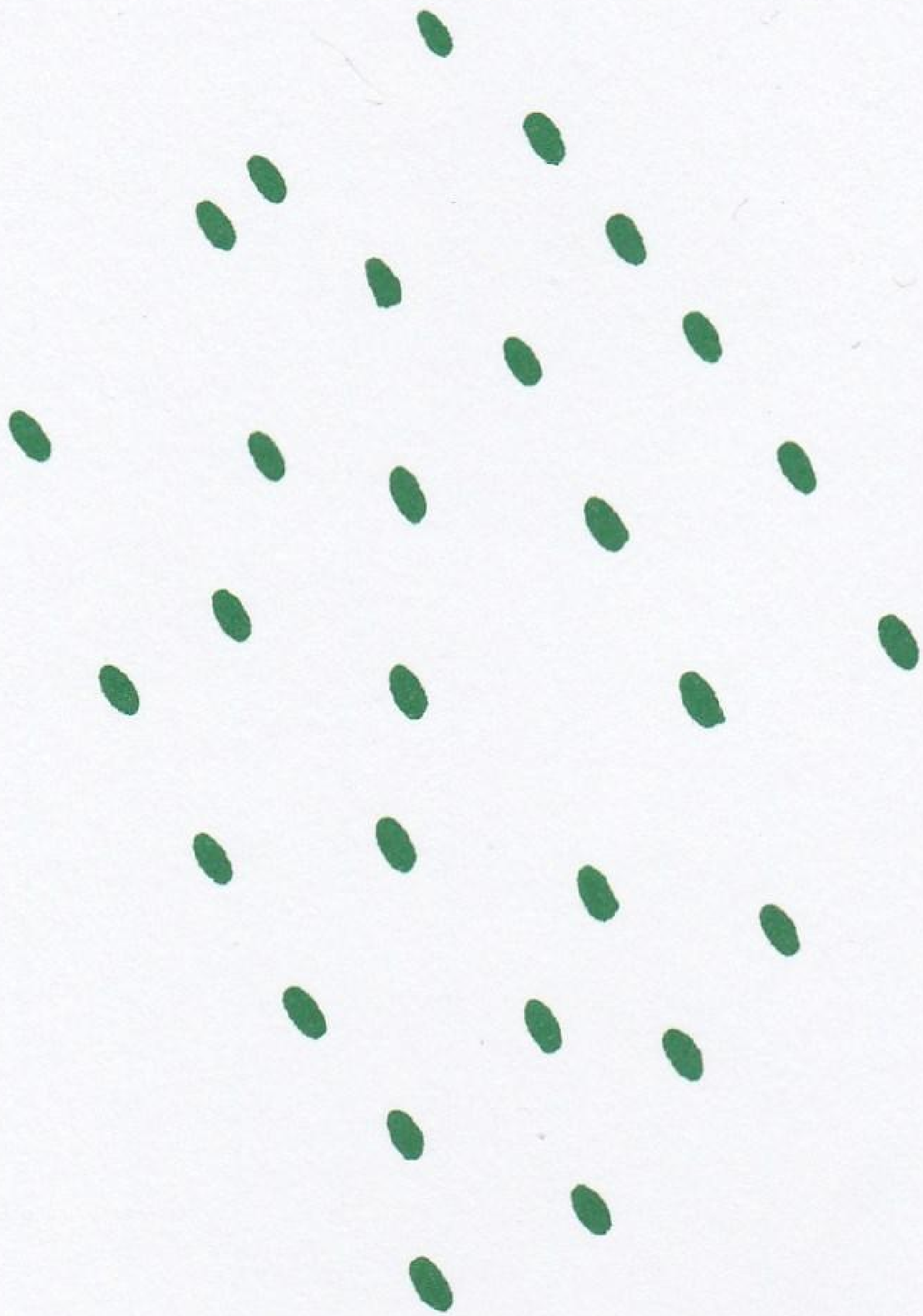

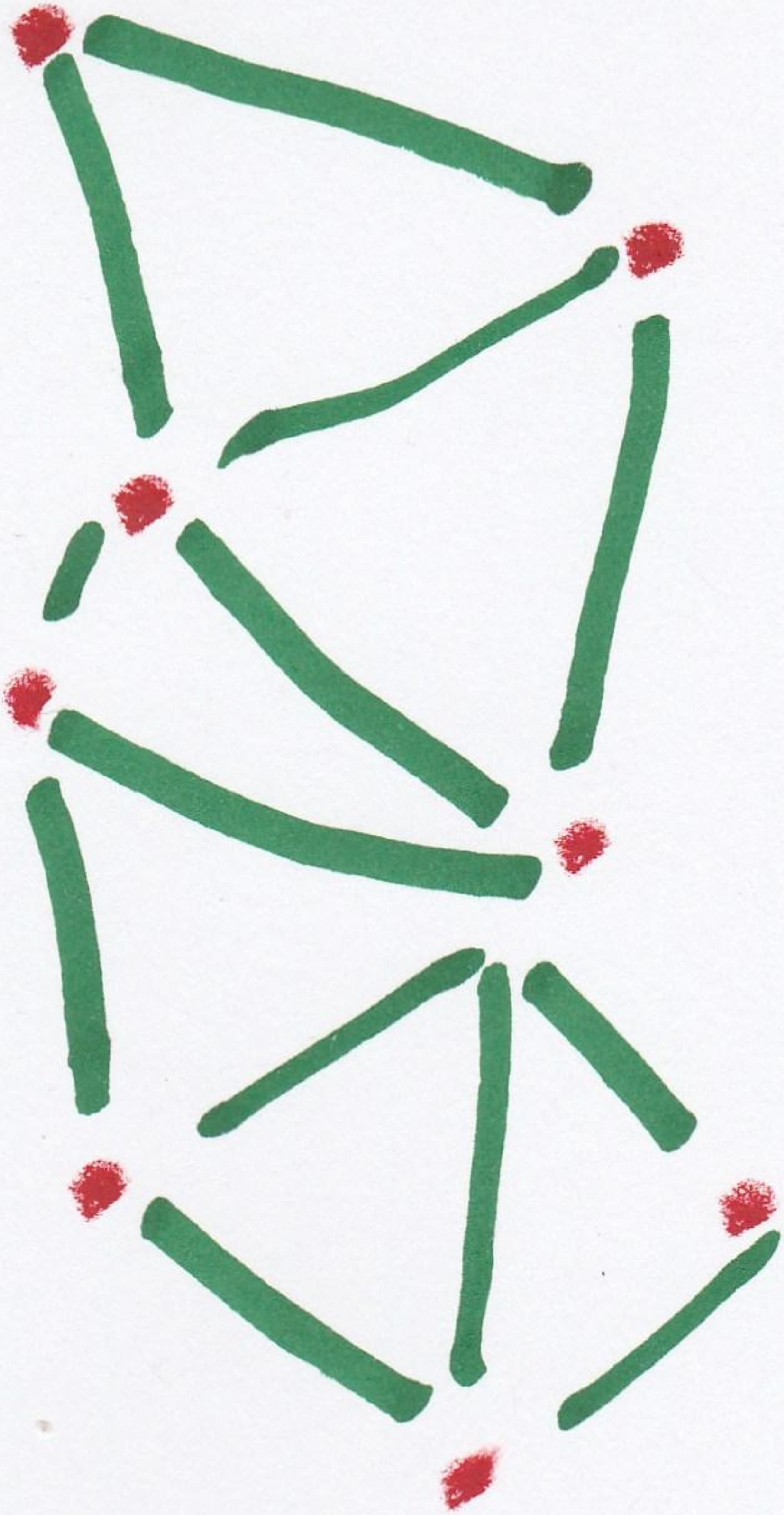

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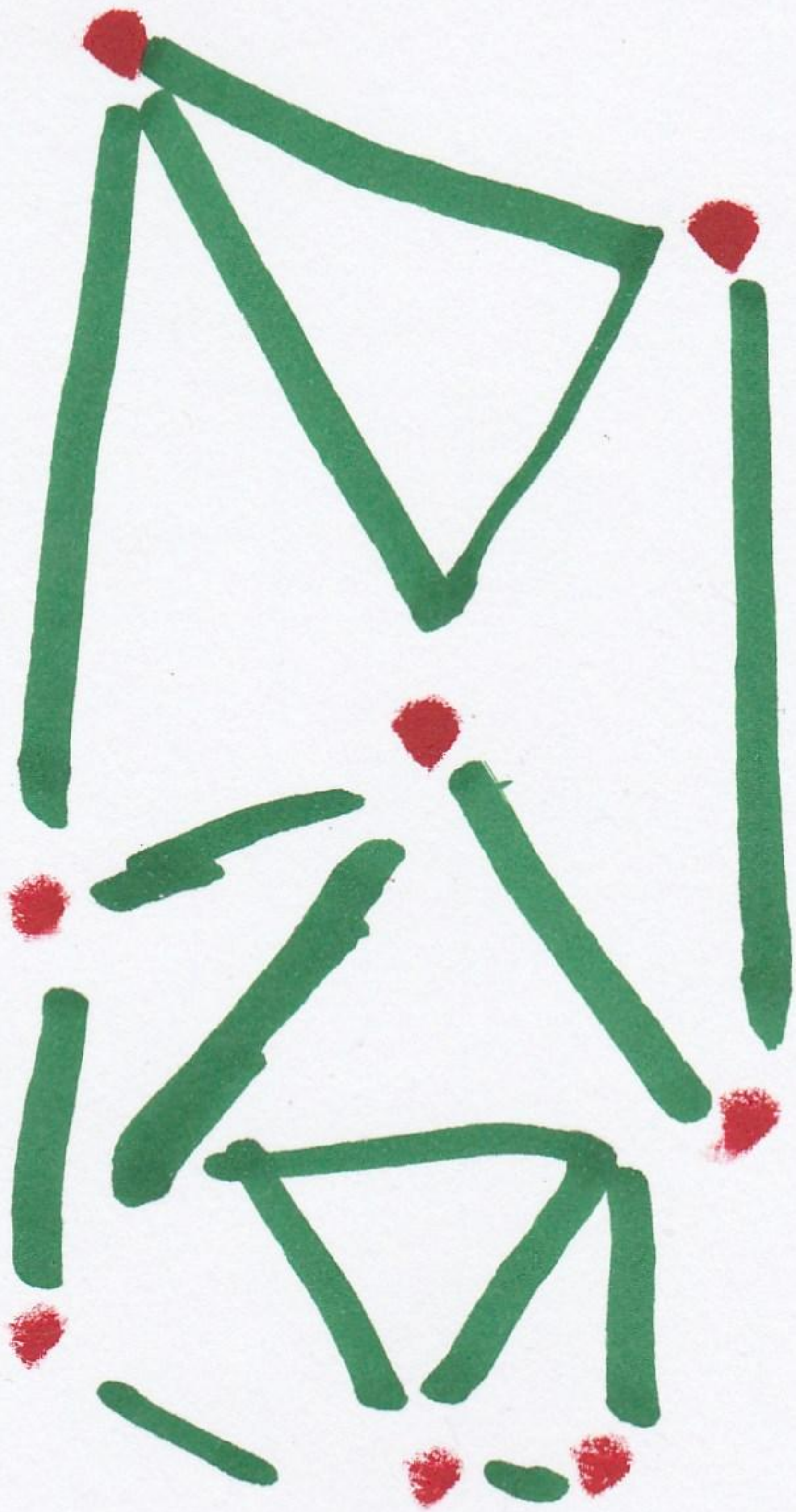

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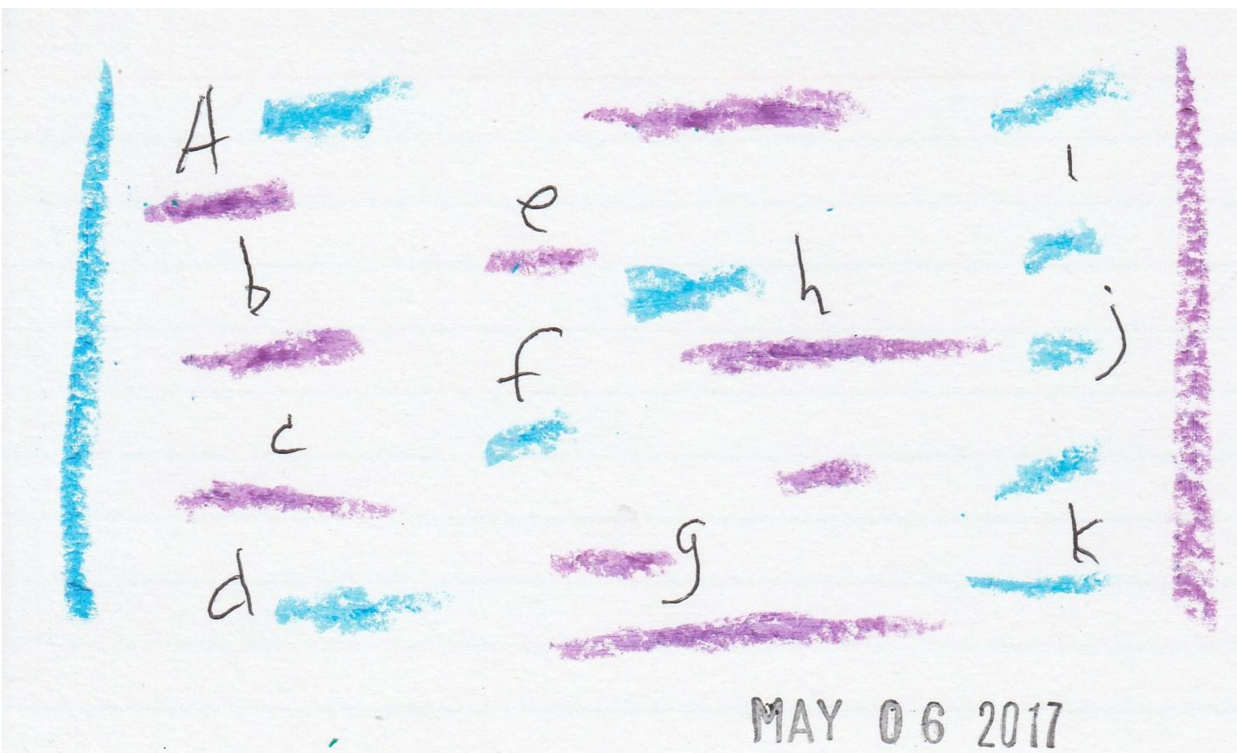
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